Power Generation

and POWER PLANT ENGINEERING

TECHNOLOGY DEPARTMENT

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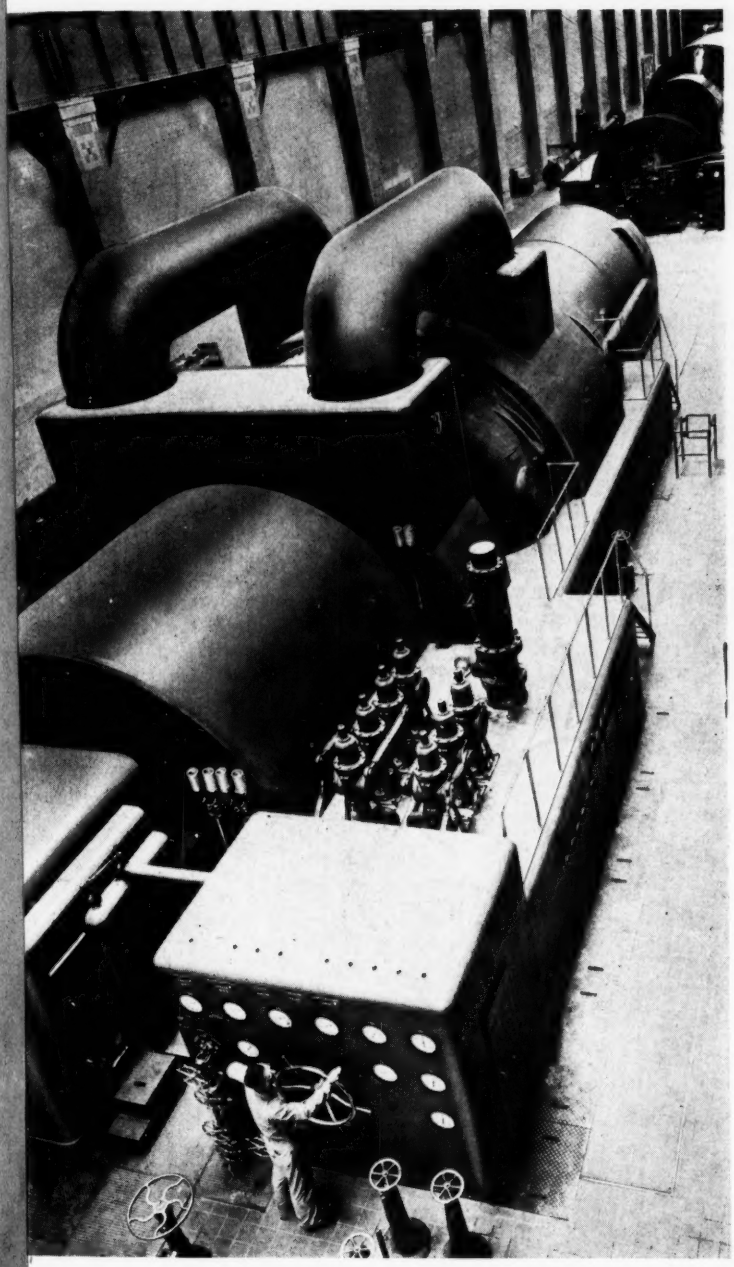

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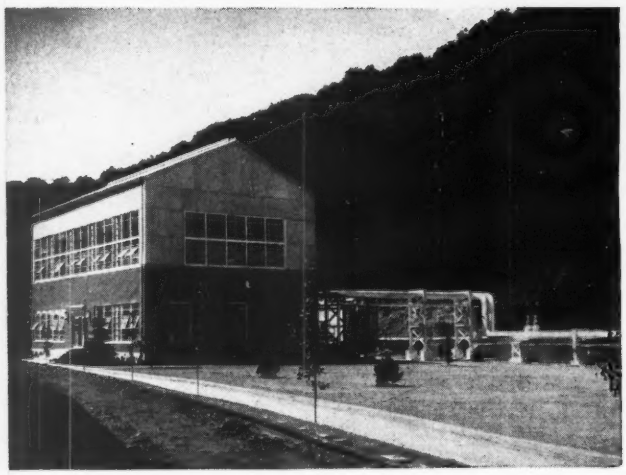
COVER: View of new Unit No. 3 at Port Washington Station, Wisconsin Electric Power Co. This unit, which went into operation in October, 1948, is an 80,000- kw, 1290- psi, 900-F, 1800- rpm tandem-compound turbine generator with reheat to 900 F. Unit No. 2 in background. (Allis-Chalmers photo).

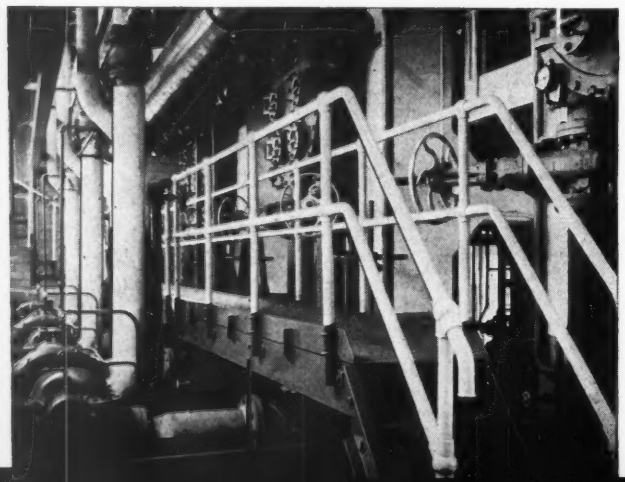
ower Engineers Responsible for Supply of Steam, Electricity and All Other Power Plant Services

Golden A



The generating plant provides all required electric power in an isolated location.

Elliott condensers serve main turbines. Circulating and condensate pumps driven by Elliott turbines.



Elliott

Plants
SI
DISTR

Anniversary Station

THIS LINE OF THREE ELLIOTT 1500-kw

straight condensing turbine-generator units went into service a few months ago at the Hastings, W. Va. compressor station of the Hope Natural Gas Company, — just as the Company celebrated its 50th anniversary.

The three Elliott turbines are served by Elliott condensers. (Numerous Elliott mechanical drive turbines and three deaerating feedwater heaters are used in the generating station, boiler plant and natural gasoline plant.)

These units provide power for motor-driven auxiliaries in the boiler house and the compressor station, for motors in the water pumping house and in the gasoline plant, and the lighting load.

The new generating plant is the climax of a modernization program which permits the company to start its second half-century with completely up-to-date and enlarged facilities. The installation is a fine example of the type of thinking which keeps operating costs to the present-day minimum by the use of new and modern equipment.

H-722

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Power Generation

March, 1949

VOLUME 53—NUMBER 3

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Contents of back issues of Power Plant Engineering and Power Generation will be found in both the Industrial Arts Index and the Engineering Index on file in Public Libraries.

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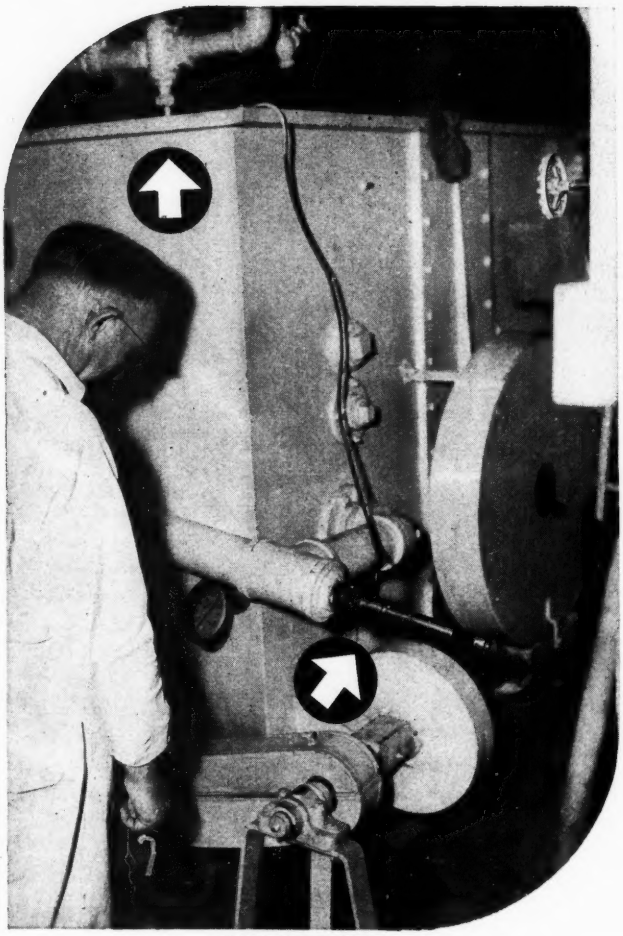
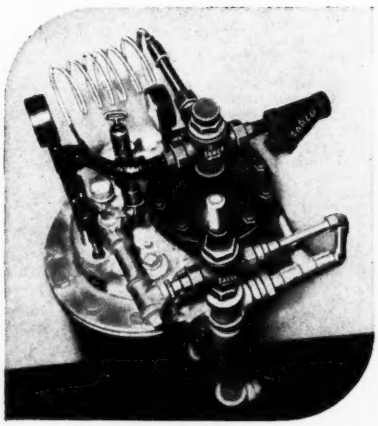
HOW SARCO SAVES WATER



CAN COOLING

This can cooler handles 40 No. 10 tins of chocolate and cooked foods per minute. The water temperature must never exceed sixty degrees, but the load and the incoming water temperatures vary. The simple hook-up of a Sarco TR-21 regulator holds the tank water within the required limits, day after day, without supervision. The water saving alone paid for the change in a few months and can cooling is now automatically uniform.

Each oil cooling system on a battery of plastic presses required a full stream of city water—a six inch pipe running wild at $500 a month for the plant. Sarco Control reduced the stream to a trickle and the entire battery and all air compressors are being Sarco equipped with a total saving estimated at $300 a month. Ask for Catalog No. 700.



WATER HEATER

You also can save hot water with Sarco by having temperatures correct at all times. The Instantaneous Water Heater shown at the right has two Sarco Controls, one for the hot water and one for blended water. Catalog No. 600.

230

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ENGINEERS' PREVIEW

BIRDS ARE SMARTER than people—especially when it comes to building their homes. Proof of this is a sparrow's nest in Paterson, N. J., built from stainless steel turnings purloined from a nearby factory yard. Pointing proudly at this sparrow's home, U. S. Steel Corp. (free plug), which dug up the item, adds proudly that stainless is "an ideal material for a rust-proof, durable home."

However, some people are not quite so much impressed as the little sparrow. The Aluminum Co. of America, planning a new steel-frame office building, turns to aluminum for the facing. The building to be erected in Pittsburgh will be a 30-story structure on which construction will get underway in mid-1950. The aluminum facing of the building will be backed up by about 4 in. of insulating material and it is expected to be "one of the most outstanding structures in the world." (second free plug).

Go it, wife!—go it, b'ar!

★ ★ ★

PART OF YOUR research service is located in the heart of Chicago, wherever *you* may be. It is at The John Crerar Library of Science, Technology and Medicine. American industry spends millions of dollars in research; competition is keen; standards are exacting; promptness is crucial. The scientific and technical library holds the solution to many of industry's problems. Through use of technical information already published, costly duplication in research can be avoided and more intelligent planning can be accomplished.

The John Crerar Library, Chicago's storehouse of scientific information, is designed for industry in this age of technology. There are 700,000 books, over 15,000 magazines and periodicals, and an indispensable accumulation of the world's knowledge. This is known, of course, to thousands of engineers and technologists in the Chicago area, but a large segment of the general public does not even know that the library exists.

At present the library is embarking on an expansion program to increase its value to Midwestern industry.

Details of all its services are given more fully in a 4-page brochure being issued by the Library.

In editing *Power Generation*, we find frequent occasion to call upon the Library for assistance, although our own power engineering library is extensive. We can recommend the Crerar services most highly from our personal experience.

★ ★ ★

STANDARDS, Definitions and Terms in use by the Fan and Blower Industry, Bulletin No. 105 and Physical Proportions of Commercial Fans, NAFM Form X-12, Fifth Edition, have recently been issued by the National Association of Fan Manufacturers. Bulletin No. 105 discusses fan types, names and definitions, then gives operating limits for various classes of fans, air density ratios, standard sizes for multi-blade and non-overloading fans, arrangements of drive and inlet boxes, and standard methods of testing fans. Form X-12 presents tables of fan sizes representing a fair general comparison, of physical proportions only, of commercial fans manufactured by member companies, with no warranty expressed or implied as to their operating characteristics. For copies, write the E. P. Editor.

BELT CONVEYOR system 130 miles long, for hauling iron ore from the Great Lakes to the Ohio River steel mills and hauling coal in the reverse direction, is being planned by a new corporation, Riverlake Belt Conveyor Lines, Inc.

This conveyor system, which would require 172 separate belts, some of them more than a mile long, would be designed to move 3400 tons of coal an hour and 5400 tons of ore. Belt widths would vary from 72 in. between the Ohio River and the Youngstown spur, 60 in. north from the spur to the lake, and 42 in. for the spur belts. The system would run from Lorain, Ohio on Lake Erie to East Liverpool, Ohio on the Ohio River. It would all be elevated at least 22 ft and entirely enclosed to prevent "unauthorized removal of the material carried by the belts"—(English, stealing). According to the estimates, the system would cost 154 million dollars and take at least three years to build. If 15 million tons of coal were carried by the conveyor system annually, according to H. B. Stewart, Jr., one of the officials of the new company, the new system would cut $1.06 a ton from the rail cost of carrying coal from the Ohio River to Cleveland or Lorain. On a 20-million ton annual basis, the saving would be $1.50 a ton. Conveying of iron ore from Lake Erie to Youngstown would be 47 cents a ton less than rail charges on a 15 million ton annual total.

Well, this conveyor system certainly wins the unspecified prize to which we called attention on page 100 of the January issue. First a 7-mile belt conveyor for the giant Bull Shoals Dam on White River, Arkansas, was entered as a contestant. Next, a 12-mile conveyor belt for the Hungry Horse Dam in Montana entered the race. Now who is going to race the 130 mile outfit for the prize?

★ ★ ★

CONSTRUCTION of a $21,000,000 hydroelectric power plant project near Anchorage, Alaska, has recently been approved by the U. S. Department of the Interior. The project will include a low dam to raise the level of Eklutna Lake and to divert water from Eklutna Creek through a 4½-mile tunnel to a 30,000-kw power plant a short distance north of the present 2,000-kw Eklutna Power Plant.

★ ★ ★

COMPLAINTS against the steel industry, based on its alleged failure to expand capacity and output adequately, are collapsing fast because supply and demand are quietly coming into balance, according to *Iron Age*. This does not mean that all consumers will be assured all the steel they may want. But it does mean that the situation will be something like 1936 to 1938, when deliveries were delayed as much as 22 weeks, but there was no outcry for more capacity and output. Right now the unprecedented output of steel is throwing confusion into the ranks of the economists and chart-makers. For the third week this output has been at an annual rate of 97 million ingot tons. For the first time since the war, there is talk by consumers about not taking some of their quotas; and gray market supplies are even going begging. Nevertheless, this does not mean a dip in output, for many people still want more steel.

SPECIAL TYPE of parachute, used for lowering delicate instruments shot into the upper atmosphere in experimental rockets, may have important applications in other fields of aviation. Known as a rotochute, the device resembles a giant dart with a whirling propeller at its tip. It was developed by General Electric Co. The rotochute is carried in a rocket and at the peak of flight it is expelled. As it falls and the air becomes denser, the blades on the tip begin to revolve and are gradually forced into a horizontal position and act as a brake, slowing the unit to approximately 27 miles an hour by the time it reaches the ground. Besides dropping material from rockets and planes by this device, it might even be worked out as an escape capsule for airplane passengers or rocket pilots; and it might even be possible to lower an entire rocket by means of such a rotochute, instead of allowing research rockets to be completely destroyed when landing, as at present.

★ ★ ★

FIRST MASTER'S degree in mechanical engineering for a woman ever awarded by Illinois Institute of Technology, Chicago, Ill., was presented January 29 to Lois Graham, daughter of Paul S. Graham, Professor of Physical Education at Rensselaer Polytechnic Institute. After she was graduated from Troy High School in 1942, she enrolled at Rensselaer as one of the first four women engineers to be accepted by that college. Of the three girls who entered with her, only one other, a metallurgical engineer, completed the course. Miss Graham attained distinction in this course, where all her classmates were men. Her grades were exceptional and she was a member of honorary societies Tau Beta Pi, Pi Tau Sigma, and Sigma Xi and of the ASME.

In less than three years she was graduated from Rensselaer and in April 1945 began work as a mechanical engineer in the development division of the Carrier Corp., Syracuse, N. Y. In the fall of 1946, she accepted a graduate assistantship at Illinois Tech. She specialized in the study of air conditioning and taught two laboratory courses at Illinois Tech. In one graduate mathematics class, there was one other woman student; Otherwise her scholastic company remained the same—all men.

Miss Graham has accepted a position as instructor in mechanical engineering at Illinois Tech and intends to work toward a doctorate. Discussing mechanical engineering for women, she says. "There are a few jobs a girl can't do and occasionally one will meet a person who is prejudiced against women in the field. But a woman mechanical engineer *can* do well, and, in general, I've been treated very nicely." Would she recommend that other girls follow her lead? "Yes. I would say, if you want to become a mechanical engineer, become one."

★ ★ ★

MORE WIDESPREAD but more intelligent demand for smoke abatement in the industrial cities of the country is reported by Chairman H. B. Lammers of the Coal Producers Committee for Smoke Abatement. It has finally been made clear that if our cities are to be made free of smoke it must be accomplished plant by plant and through a spirit of co-operation rather than by use of the "big stick." To promote this attitude, the Committee is distributing an attractive brochure entitled, The Coal Producers Attack Smoke. This discusses the program and activities of the Committee, organization and purpose, services offered, accomplishments, observations and broad policy.

RADIOACTIVE PISTON RINGS may lead to lower internal combustion engine maintenance, especially in automobile engines. The California Research Corp., subsidiary of the Standard Oil Co. of California, and the Isotopes Division of the Atomic Energy Commission, announce that the Corporation's research staff is successfully using such radioactive rings to test the effect of fuels and lubricants on engine wear. By a very simple test, as little as one-millionth of an ounce of metal worn from such rings can be detected. The rings are irradiated in the chain-reacting pile, as one of the services to American industry, at the Oak Ridge National Laboratory.

In another experiment the corporation has developed a method to tell just where a given sample of oil is located in a pipeline, by a test outside the pipe, with a Geiger counter. To do this, about one-billionth of an ounce of radioactive barium is added to the oil before it is pumped into the pipe.

Still another experiment is on use of radioactive isotopes in improving petroleum fuels. This is done by substituting a radioactive carbon atom for an ordinary carbon atom in the fuel and, by means of a Geiger counter and other necessary equipment, studying what happens to it as the gasoline molecules pass through the complex operations of the modern refinery.

★ ★ ★

PUBLICATION in a single pamphlet of a series of papers on the subject "What Good are Standards?" was recently announced by American Standards Association. These papers were presented at the 1948 annual meeting of the Association and include discussions of such important problems as legality of standardization, the standardization work of the Munitions Board, and the functions of standardization in such company operations as purchasing, manufacturing and marketing. Copies may be obtained for $1.00 each from the American Standards Association, 70 E. 45th Street, New York 17, N. Y.

★ ★ ★

REQUIREMENTS of an American family change rapidly, said Louis B. Wetmore, Executive Director of Providence Redevelopment Agency, Providence, R. I., before the 96th Annual ASCE Meeting. A family of two starts with minimum space requirements. For 10 or 15 years the home expands; it then contracts for a similar period until it again has to meet the original requirements for a family of two. Segregation of apartments in one section of the city makes it necessary for a family, as it grows or contracts, to move about and break its ties with a neighborhood and friends of years standing. This could be obviated by providing a number of different types of housing within the neighborhood, so that the family could meet its changing housing needs without uprooting its social life. This interesting conception he explained in detail, showing how work is underway in Providence in planning a new residential community of this type, consisting of 1200 homes to house 5000 persons, with residences ranging from apartments to group housing and single family dwellings.

★ ★ ★

BRAKING of multi-engined airliners in flight has been demonstrated by Curtiss-Wright Corp. This is done by reversible propellers, which can enable multi-engine aircraft to descend during emergency or procedure letdowns safely at rates exceeding 10,000 ft per minute with air speeds below 200 miles per hour.

protect your
POWER OUTPUT

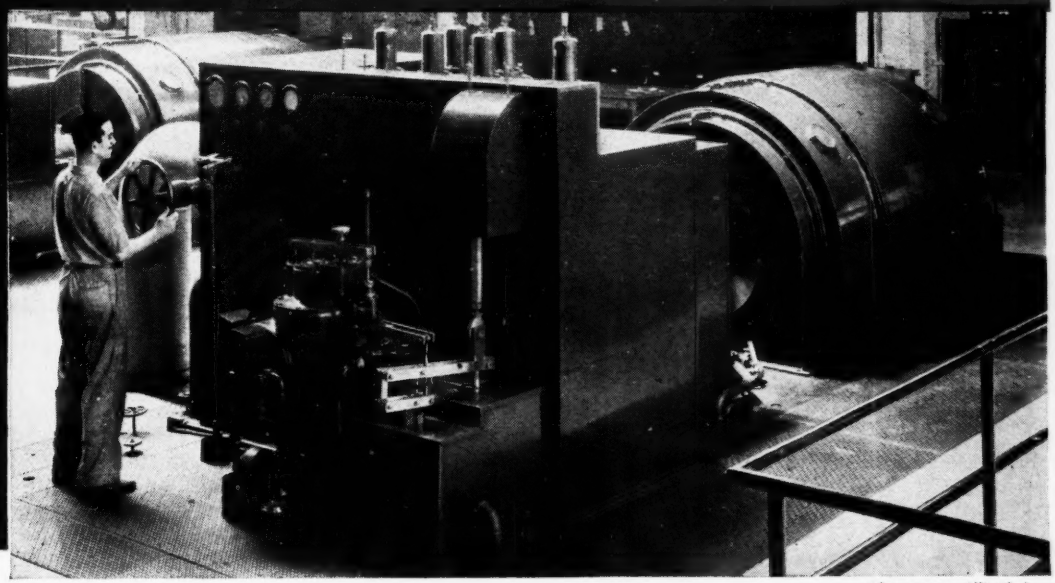

Photo courtesy Allis-Chalmers

Keep your turbines on the line with Texaco Regal Oils (R&O)
They provide an extra margin of safety

WITH high power demands still forcing many turbines to be run continuously under heavy load, this is no time for power failure. Keep your turbines on the line by protecting them with *Texaco Regal Oils* (*R & O*)—the oils with *an extra margin of safety.*

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The use of *inhibited* oils is strongly recommended by turbine manufacturers, and *Texaco Regal Oils* (*R & O*) meet the stringent requirements of all leading turbine builders, and the turbine oil specifications of the U. S. Navy.

Let a Texaco Lubrication Engineer help increase efficiency in your plant through more effective lubrication. Call the nearest of the more than 2300 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

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Tune in...TEXACO STAR THEATRE presents MILTON BERLE every Wednesday night. METROPOLITAN OPERA broadcasts every Saturday afternoon.

A *New* YARWAY AID TO . . .

BETTER POWER

HI-LO-GRAPH LIQUID LEVEL RECORDER

Permanent, hour-by-hour records of boiler water levels can be charted with the new Yarway Hi-Lo-Graph.

The Hi-Lo-Graph not only *records* . . . it also *indicates* boiler water level changes. Brightly lighted active section of the chart makes pen arm clearly visible as indicator.

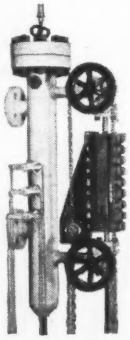
Indication is *instant* and *accurate* because the Hi-Lo-Graph is operated by the boiler water itself. No stuffing boxes. Actuating mechanism is never under pressure.

Easily installed on new or existing boilers. Designed for wall or panel mountings. For all pressures up to 2500 psi.

For complete description, write for new Yarway Bulletin WG-1830.

YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia 18, Pa.

OTHER YARWAY LIQUID LEVEL INDICATING EQUIPMENT



WATER COLUMNS AND GAGES

Yarway columns feature the *floatless* Hi-Lo-Alarm Signal. Two types of gages—Sesure Inclined and Vertical Flat Glass. Write for Catalog WG-1811.

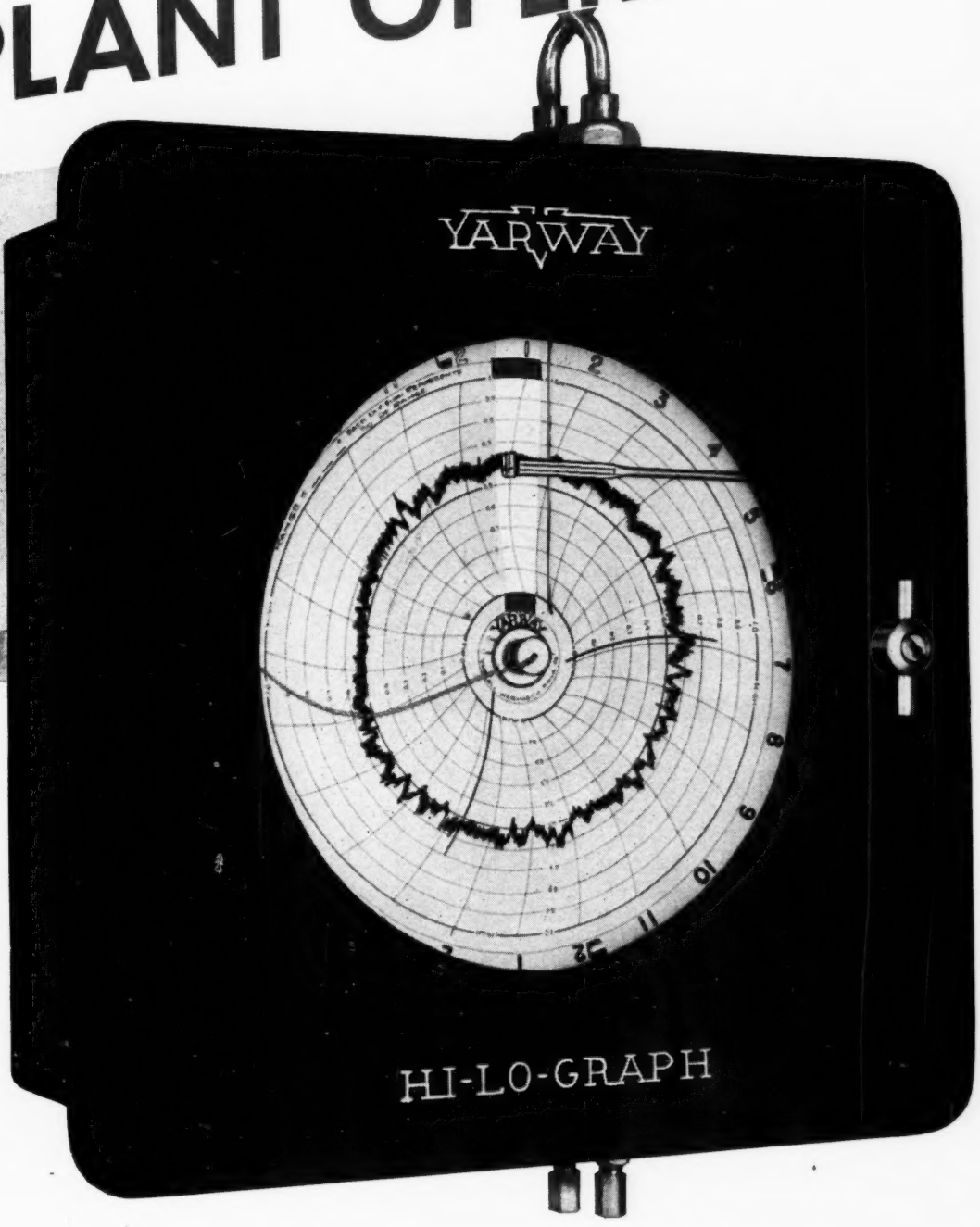
REMOTE LIQUID LEVEL INDICATOR

Brings overhead gage readings right down to eye level—on instrument panel or other convenient place. *Instant, accurate* indication. Completely described in Catalog WG-1822.

REMOTE HORN AND LIGHT SIGNAL ALARMS

Operated anywhere in power plant by Control Unit located on YarwayRemote Liquid Level Indicator. Completely described in Catalog WG-1822.

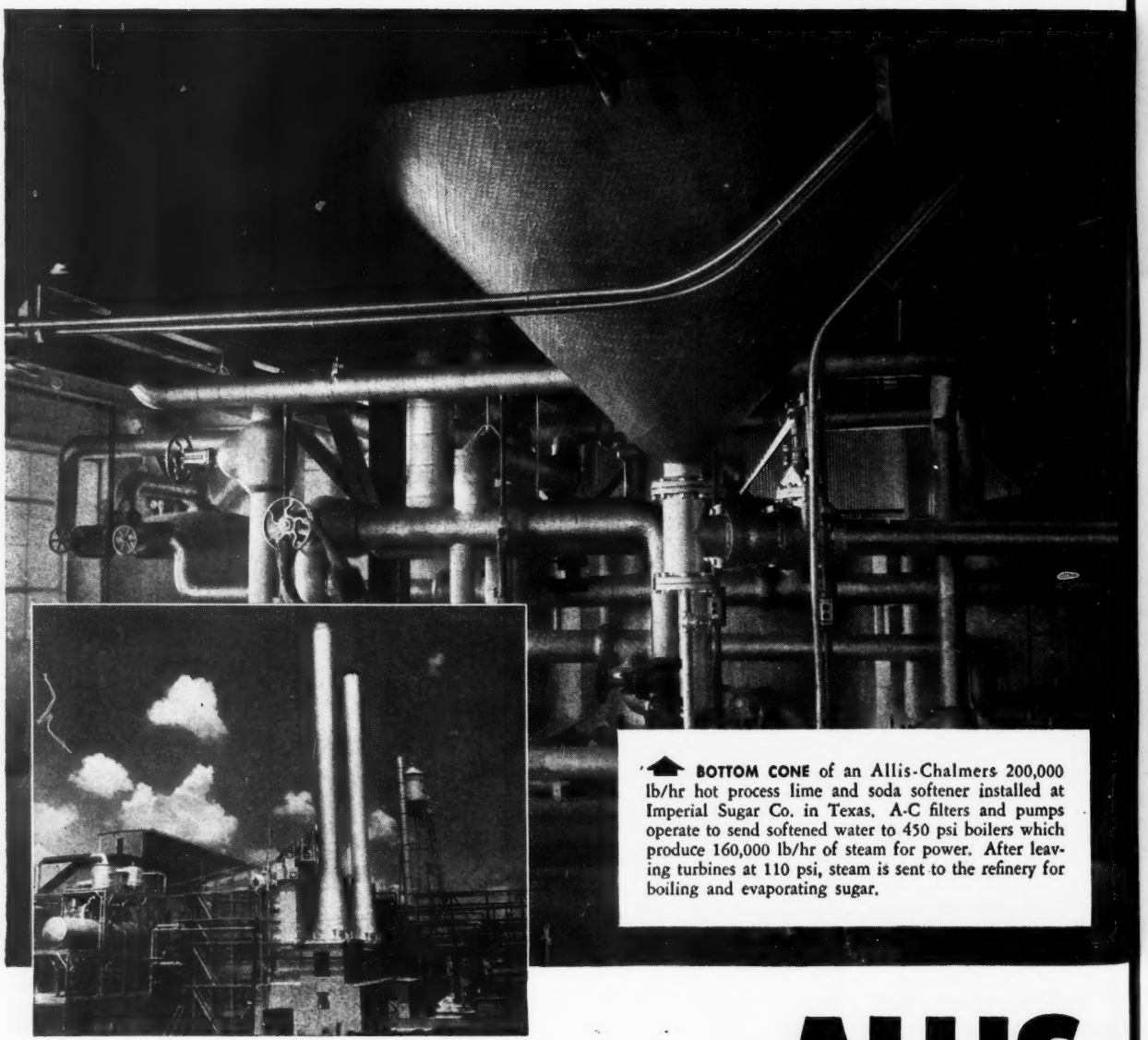
PLANT OPERATION



YARWAY **POWER PLANT EQUIPMENT**

ONE OF A SERIES • • • *Allis-Chalmers Water Conditioning*

3-way program water treatment



BOTTOM CONE of an Allis-Chalmers 200,000 lb/hr hot process lime and soda softener installed at Imperial Sugar Co. in Texas. A-C filters and pumps operate to send softened water to 450 psi boilers which produce 160,000 lb/hr of steam for power. After leaving turbines at 110 psi, steam is sent to the refinery for boiling and evaporating sugar.

CLEAN STEAM for sugar processing leaves the new power plant for the Southwest's leading sugar refinery, helping to produce 1,600,000 lb of refined sugar per day.

ALLIS-
Water Conditioning

SERVICE • CHEMICALS • EQUIPMENT) *at Work in Industry*

helps you solve problems!

WHAT ALLIS-CHALMERS *SERVICE-CHEMICALS-EQUIPMENT* DOES FOR THESE FOOD PLANTS—IT CAN DO FOR ANY INDUSTRY THAT NEEDS COMPETENT TIME AND MONEY SAVING AID!

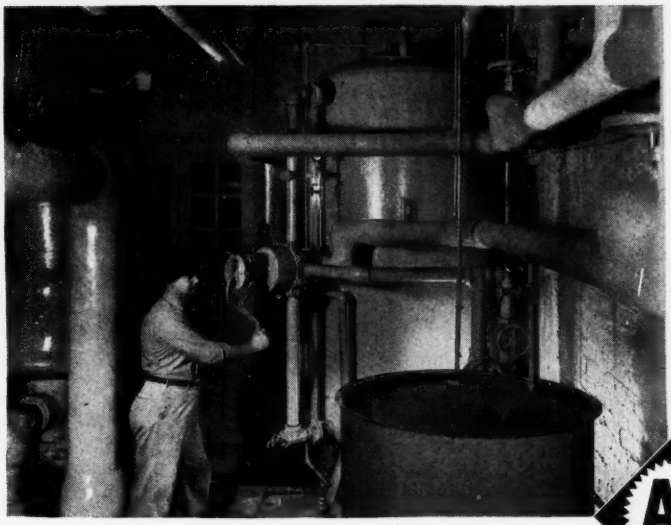
PLANT MEN IN FOOD-PRODUCING industries like sugar refining and dairying, for example, know the need for action when water treating problems arise. They know, too, that to work with a competent water conditioning organization means a savings in time and effort for all concerned.

For *all* industries, Allis-Chalmers in the water conditioning field not only provides a first hand study of water treating needs, but works right along with customer engineers in selecting the right process and correct equipment.

ALLIS-CHALMERS SERVICE starts with a complete study of water supplies and impurities, surveys of present methods and plant operating conditions. Following this: recommendations, selection of chemicals, periodic reports, and service calls.

CHEMICALS comprise a complete new line of formulations for scale and corrosion control in all types of cooling towers and heat exchangers. Also reliable AKON and SILIMITE which effectively prevent boiler scale and corrosion . . . reduce silica.

EQUIPMENT includes hot and cold process softeners, sodium and hydrogen zeolite softeners, degasifiers, deionizers, chemical proportioners, and oil removal and water filters.



SODIUM ZEOLITE softener at Pabst Farms Dairy in Wisconsin is a 9,000 gal unit treating extremely hard well water for steam-pasteurizing and evaporating fresh milk.

Akon and *Silimite* are Allis-Chalmers trademarks

A-C ALLIS-CHALMERS

CHALMERS

Service . . . Chemicals . . . Equipment

ALLIS-CHALMERS, 953A SO. 70 ST.
MILWAUKEE, WIS.

Please send me:

- ☐ 6385A Chemicals and Equipment, Analysis Instructions and Price List
- ☐ 6611 Description of Hot Process Water Softeners
- ☐ 7107 Sodium Zeolite Softeners

Name.....

Company.....

Title.....

City.....

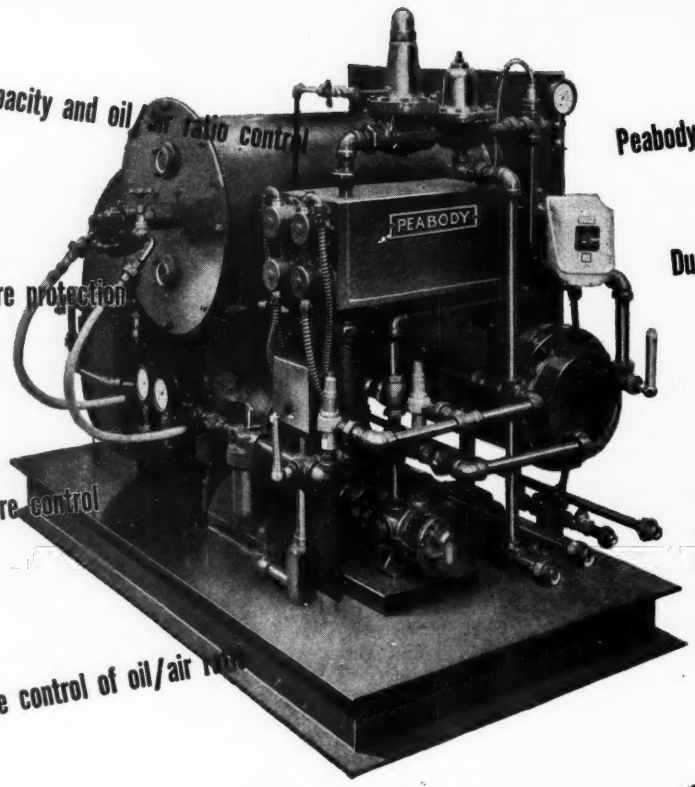
State.....

A 2639

announcing

THE

PEABODY Automatic Oil



Automatic control of capacity and oil/air ratio control

Peabody Constant Differential System

Dual gas-electric ignition

Electric eye flame failure protection

Positive oil temperature control

No costly checker work floor, nor secondary air lanes under furnace walls and floor.

No field assembly, piping or electrical work.

Forced draft, positive control of oil/air

Shipped as one complete factory-built unit, ready for

LISTED BY UNDERWRITERS LABORATORIES, INC.

An automatic wide-range oil-burning system assembled complete on one base for all types of boilers and furnaces from 100 developed HP and up!

Burner

Designed for fully-automatic and semi-automatic control!

THE Peabody Automatic Burner is a complete, compact, fuel-oil combustion system that takes heavy Bunker "C" or lighter fuel oil from your storage tank, pumps it to the required pressure, preheats and delivers it to the burner at the proper viscosity, ignites it and then burns the oil at the specified firing rate as dictated by operating demands.

The product of more than two years of research and development, the Peabody Automatic Burner is ruggedly constructed, safe and simple to operate, easy to maintain and dependable and efficient in operation. Quiet, slow-speed operation of pump eliminates excessive noise and high maintenance costs. Complete details on request, and specific application data available without obligation. Call or write our nearest office located in all principal cities.

Available Now! Send for Bulletin 400, Today

PEABODY
Engineering Corporation

PEABODY Engineering Corp.
581 Fifth Avenue, New York 19, N. Y.

Please send me Bulletin 400 giving details and specifications on the Peabody Automatic Oil Burner.

NAME..... TITLE.....

FIRM.....

ADDRESS.....

CITY..... ZONE..... STATE.....

309

service connections

Turbine lubrication costs

CASE STUDY

Annual Savings in Turbine Lubricating Costs with Nonpareil Turbine Oil in a Midwest utility.

Turbine ..... 35,000 KW, 1800 RPM
Oil System Capacity .... 2800 gallons
Operation ... 1931 to 1937 on Turbine Oil X at 45¢ per gallon
Operation ... 1938 to 1948 on Nonpareil Turbine Oil at 87¢ per gallon
Annual Cost of Lubrication with Turbine Oil X ..... $ 911.57 *
Annual Cost of Lubrication with Nonpareil Turbine Oil ..... $ 284.13 *
Annual Saving 68.8%

CASE STUDY

Annual Savings in Turbine Lubricating Costs with Nonpareil Turbine Oil on a large utility turbine.

Turbine ..... 80,000 KW, 1800 RPM
Oil System Capacity .... 8,000 gallons
Operation ... Dec. 1935, to April 1942, on Turbine Oil Y at 39¢ per gallon
Operation ... May 1942 to Jan. 1948 on Nonpareil Turbine Oil at 88¢ per gallon
Annual Cost of Turbine Lubrication with Turbine Oil Y ..... $ 575.30 *
Annual Cost of Lubrication with Nonpareil Turbine Oil ..... $ 503.93 *
Annual Saving 12.4%

STANDARD OIL COMPANY (INDIANA)

CUT...up to 68%

NONPAREIL Turbine Oil

"Will outlast your turbine"

STUDIES have been made of typical utility company operations to determine how much the *price* of turbine oil affects the *cost* of turbine operation. Three such studies are summarized here. In each case, the price of the original fill of oil was 38% to 55% *less* than that for Nonpareil. But in each case the total annual cost for lubrication, when all factors are considered, show a saving with Nonpareil.

You can find out how much Nonpareil will save on your lubricating costs. Standard Oil Lubrication Engineers have facts and figures to help you determine what would be your costs with Nonpareil for comparison with your present costs.

Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois, to secure the services of the Engineer nearest you.

CASE STUDY

Annual Savings in Turbine Lubricating Costs with Nonpareil Turbine Oil in a Midwest utility system.

Turbine ..... 20,000 KW (Now 30 years old)

Oil System Capacity .... 550 gallons

Operation ... June 1940, to Aug. 1944, on Turbine Oil Z at 55¢ per gallon

Operation ... Oct. 1944 to Oct. 1948 on Nonpareil Turbine Oil at 89½¢ per gallon

Annual Cost of Lubrication with Turbine Oil Z ..... $ 83.90 *

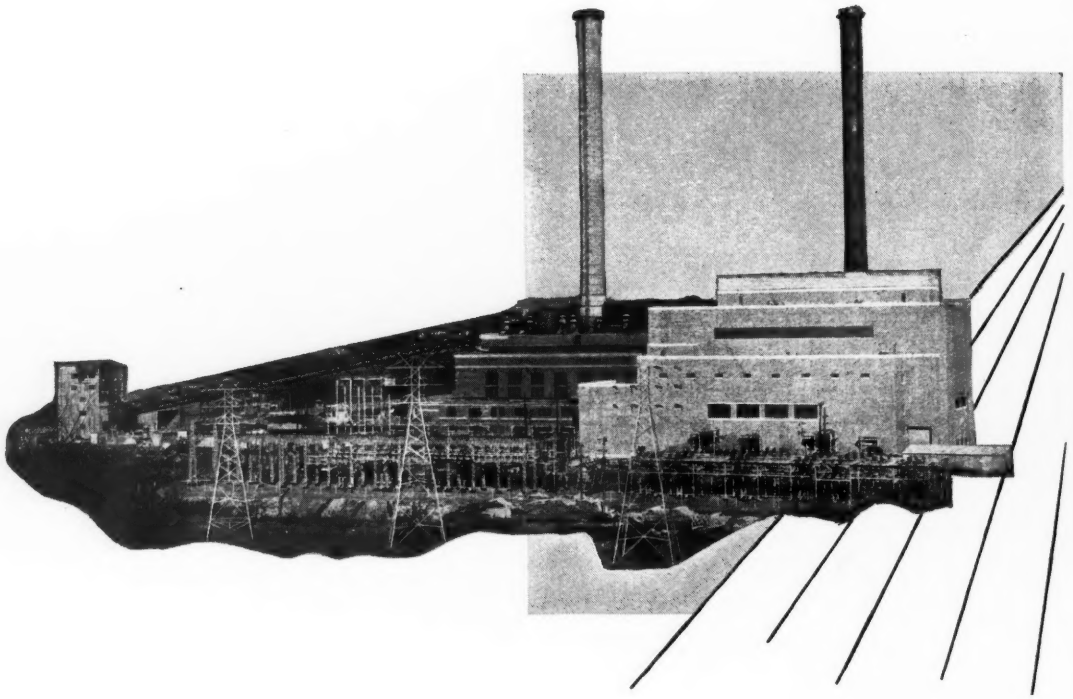
Annual Cost of Lubrication with Nonpareil Turbine Oil ..... $ 69.49 *

Annual Saving 17.2%

* Includes (1) cost of original fill, (2) oil replacements, (3) oil treating or sweetening, (4) cleaning turbine oil systems, (5) filter maintenance, where these items apply.

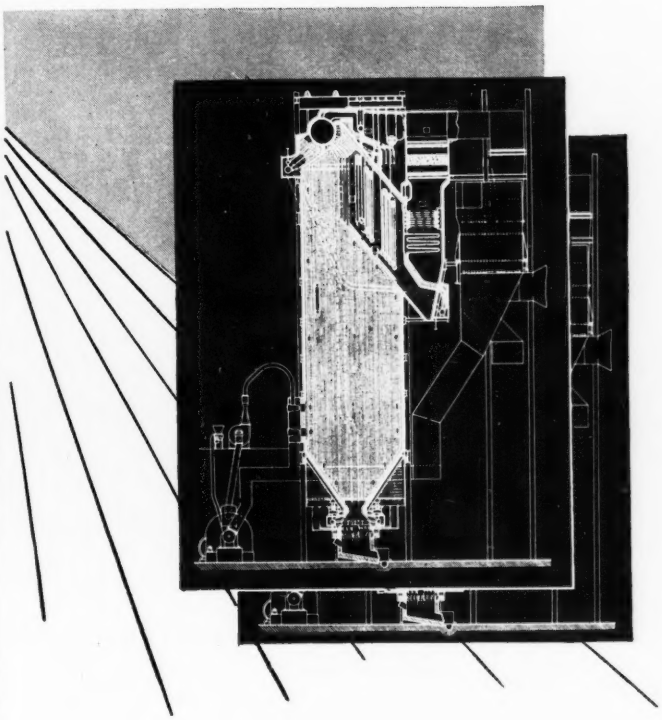
STANDARD OIL COMPANY (INDIANA) STANDARD

Looking ahead



The new extension of the Barbadoes Station of the Philadelphia Electric Company houses two large Foster Wheeler steam generators which are capable of producing a total of 1,200,000 lb of steam per hr. The units will serve two turbine generators with an aggregate capacity of 132,000 kw.

These single-pass, baffleless steam generators having liberal furnace dimensions, are based on what is now known as the "Preferred Standard" design which promises both first cost savings and long range economy. The design also embodies Foster Wheeler features of slag-free fur-



TWO FOSTER WHEELER STEAM GENERATING UNITS for BARBADOES STATION PHILADELPHIA ELECTRIC CO.

Steam Capacity per Unit
600,000 lb per hr

Superheat Control Range
330,000 to 600,000 lb per hr

Pressure Superheater Outlet
825 psi

Final Steam Temperature
900 F

Bituminous Coal Pulverized in FW Ball Mills (two per unit)

nace arrangement, Foster Wheeler condenser-type steam temperature control, low draft loss, and efficient heat recovery arrangement. Each steam generator is equipped with two Foster Wheeler ball mill pulverizers.

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, NEW YORK.

FOSTER FW WHEELER

an old installation brought a new installation of

HAGAN Controls

at MARION POWER SHOVEL COMPANY

Hagan Controls had been in service for 15 years at the plant of Marion Power Shovel Company, Marion, Ohio, when the Company decided to replace the old boilers and modernize its power plant. This long experience with Hagan controls was a major factor in their selection of Hagan Controls and Hagan Ring Balance Meters for the new boilers.

The new boilers are rated at 35,000 lb./hr. at 125 lb. pressure. They are stoker fired, using a spreader type stoker.

During the summer, steam demand ranges from 2,000 to 15,000 lb./hr. Base demand in winter is much higher, for steam is used to heat 20 buildings of various types, spread over 25 acres of ground. Winter load, therefore, may vary between 50,000 and 63,000 lb./hr. Steam hammers are used in the factory, and when the hammer line goes on, demand may increase almost instantly by as much as 13,000 lb./hr.

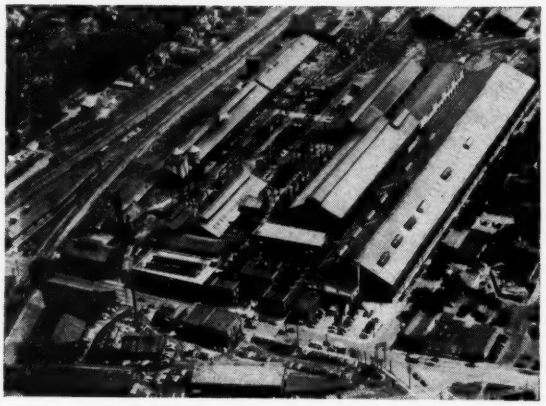
The boiler meter chart at the right shows how closely the boilers follow fluctuations in demand. Careful records of coal produced and steam consumed show that boiler efficiency runs slightly over 79%, with load at approximately 55% of rating. CO_2 tests range from 13.5% to 13.8%.

The Hagan Ring Balance Steam Flow-Air Flow Meters are of the simple two-pen recording type, with integrators which give a continuous indication of total flow.

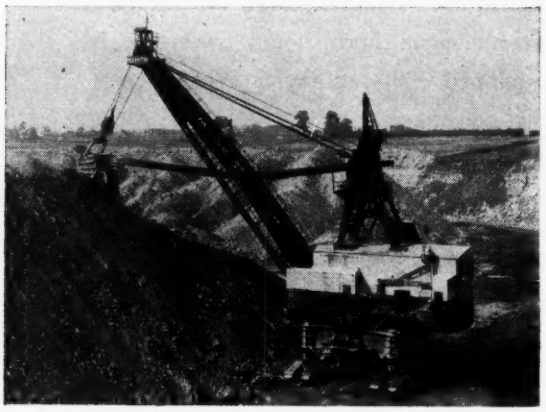
HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTOMO FORCE MEASURING DEVICES

For full information about Hagan Automatic Combustion Controls and Hagan Ring Balance Meters, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

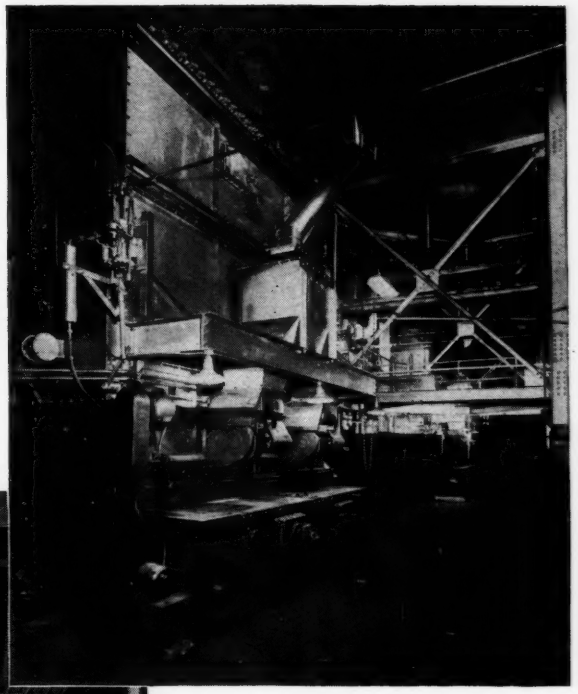


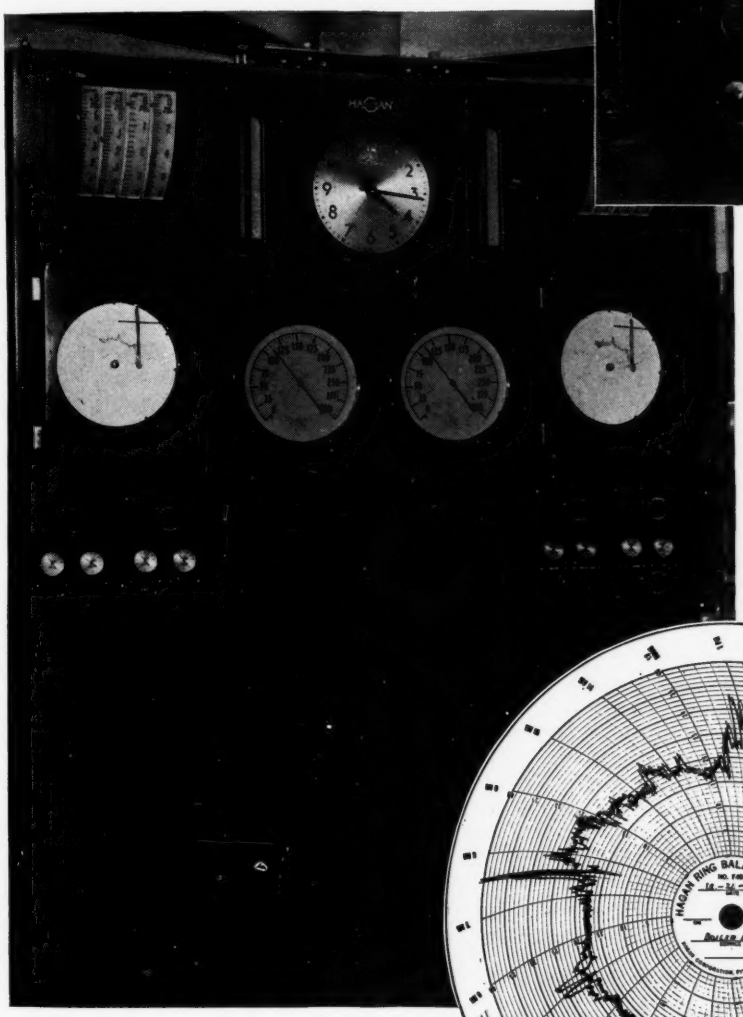
Boilers provide steam heat for 20 buildings of all types, spread over 25 acres of ground.



This giant shovel is typical of the Company's products. Scoop will hold 40 cubic yards of earth; cab is as large as the average house.

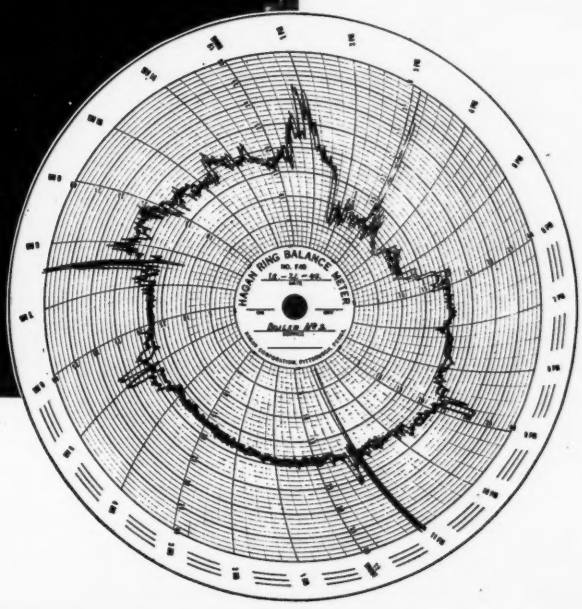
and Meters





Boiler room of Marion Power Shovel Company, Marion, O. The installation was designed and supervised by Frederick L. Smith Co., consulting engineers, New York, N. Y., and Rex Kilbourn, Plant Engineer of the Marion company.

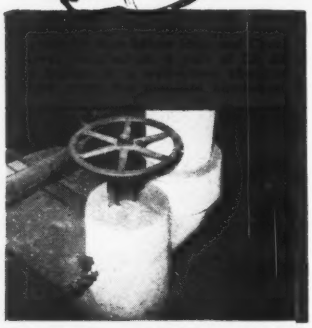
Control Panel is located at the center of the wall facing the boilers.



3 WAYS TO KEEP OUT OF TROUBLE

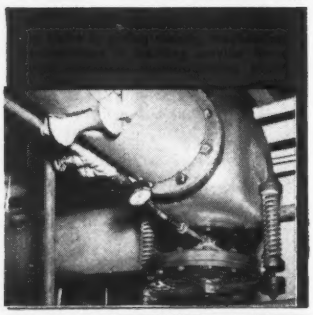
ON

MANIFOLD HEATING SERVICE



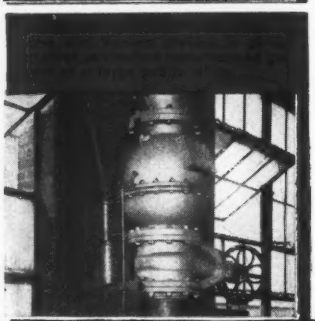
Automatic Non-Return Valve, serves as stop and check valve, necessary when more than one boiler serves the same manifold. Outside yoke and handwheel for manual closing — insures positive protection for repairmen when the boiler is down — permits boiler isolation when running separate tests — protects against discharge of steam in case of manifold failure.

Low pressure drop across the seat due to large areas in relation to pipe line sizes. Single seat, guided main valve with internal dash-pot cushion. Sizes 2½" to 12", flanged in angle, globe or elbow types. Standard for 250# saturated steam, 475°F. is semi-steel with bronze trim and alloy steel seat ring; others, suitably trimmed are available for pressures to 1500# and 900°F. Globe type, supplied without screw and yoke for a full sealed line where manual closing is not required, is frequently used as a horizontal check valve in gas or liquid service where exceptional reliability is required.



Type J-2 Pressure Reducing Valve serves as a make-up valve between the high pressure manifold and the low pressure manifold, so that heating demands are met in spite of any deficiency in supply of exhaust steam from the auxiliaries. Because of its double seated, direct-acting construction, it follows pressure variations in the low pressure manifold rapidly and provides a smooth flow regardless of fluctuations in boiler pressure or in the demand.

Type J-2 is operated by a spring-opposed diaphragm, which makes adjustment and maintenance simple. Standard construction provides for a remote service line which permits use of a relatively large low pressure manifold as a receiver. 1" to 2" sizes available with screwed connections; 2½ through 8", flanged. For initial pressures to 250#, 475°F; reduced pressures from ½# to 50#. Single seated construction available for 1"-2" sizes.



Type 34-R17 Back Pressure Valve and Vacuum Breaker protects the low pressure manifold against excess pressures, and assures proper back pressure on auxiliaries. Large area valve in relation to connected line size, provides ample capacity, and promptly relieves small build-up with reduced lift.

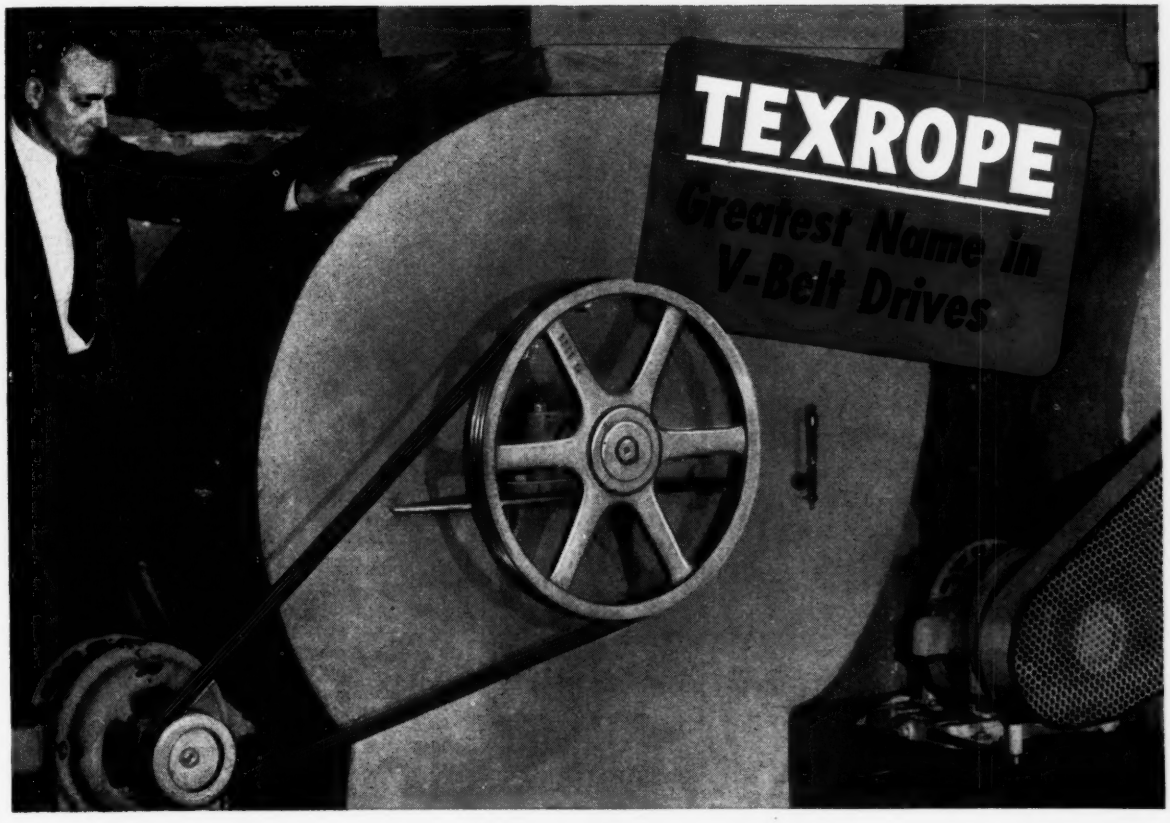
Bronze faced dash-pot prevents chattering and definitely prolongs the life of the valve. Provision is made for a water seal so that the system can be operated below amospheric pressure and still give excess pressure protection. Sizes 2½" to 8" with relief of 1# to 15#; 10" to 20" with a range of 1# to 10.# All valves flanged, and suitable for 475°F.

Other Foster Automatic Valves are available for every type of service. Foster Representatives in principal cities will work with you, without obligation, to help you with your engineering problems.

FOSTER ENGINEERING Company

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS...PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

111 MONROE STREET • NEWARK 1, N. J.



100,000 Hours

FROM ONE SET OF "SUPER-7" V-BELTS!

OVER 14 YEARS AGO, 66 complete *Texrope* drives were installed in New York's famous RCA building . . . on air-conditioning equipment for the NBC radio studios. Today, some of these *original* V-belts are still running, 20 hours a day, week in, week out!

Texrope drives were selected for two major reasons: First, they are completely noiseless and tend to dampen vibration of other parts. Second, multiple belts offer a greater safety factor, assuring service continuity. Now, after 14 years, a "bonus" of exceptionally long life has been added.

Records like this are one reason why more *Texrope* industrial V-belt drives have been installed since 1925 — when Allis-Chalmers originated the multiple V-belt drive — than any other kind.

Texrope drives offer you the widest selection of V-belt products in industry . . . V-belts, standard, adjustable and variable-speed sheaves, and speed changers.

Send for Pre-engineered Drive Manual — Lists stock components to cover 90% of V-belt drives. See your A-C dealer or District Office, or write direct for bulletin 20B6956. Also in Sweet's.

Texrope Super-7 V-belts result from the cooperative research of Allis-Chalmers and B. F. Goodrich; and are sold only by A-C dealers and offices. *Texrope* and *Vari-Pitch* are Allis-Chalmers trademarks. A 2614

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and District Offices throughout the country.

MOTORS — ½ to 25,000 HP and up. Matching Allis-Chalmers Control.

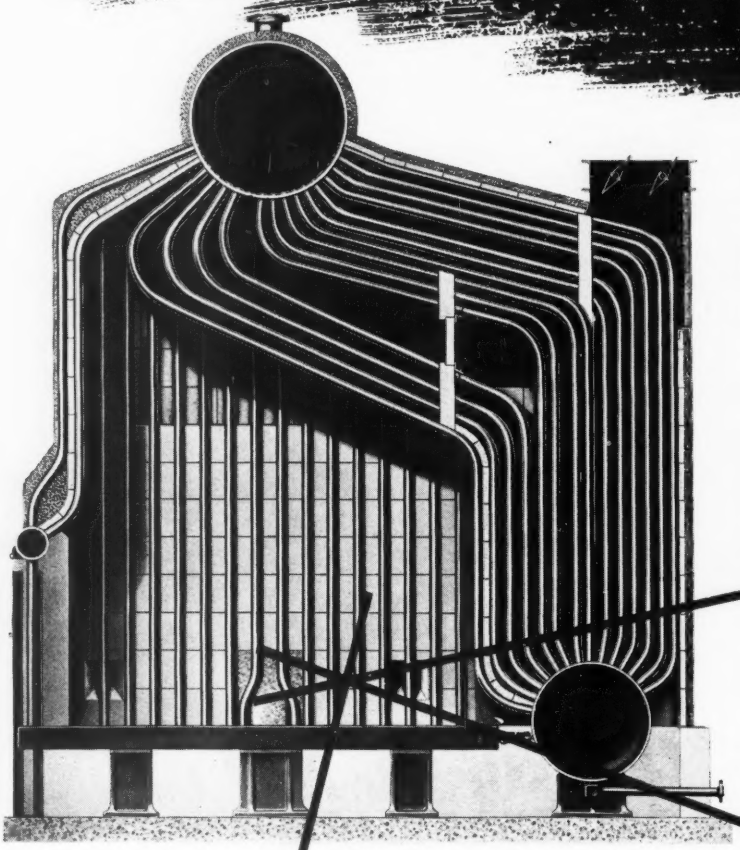
TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

PUMPS — Integral motor and coupled types. Sizes and ratings to 2500 GPM.

ALLIS-CHALMERS, 953A SO. 70 ST.
MILWAUKEE, WIS.

ALLIS-CHALMERS

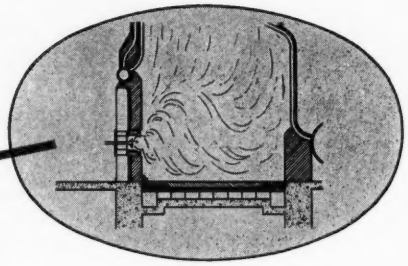
THE C-E PACKAGE BOILER



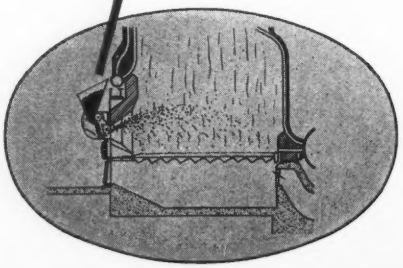
Furnished in capacities of

10,000 to 50,000

lb of steam per hr, the Package Boiler is designed for four methods of firing — spreader stoker, single-retort underfeed stoker, oil or gas burners. Any of these methods may be substituted for any other should a change in the fuel market make a change in firing equipment desirable.



OIL OR GAS BURNERS — The Package Boiler is ideally suited to the use of either oil or gas. Designed for front wall firing, the furnace is properly proportioned for the normal flame characteristics of the burners and provides ample volume for completion of combustion before the gases enter the boiler.



C-E SPREADER STOKER — Installations of C-E Spreader Stokers throughout the United States and in many foreign countries have demonstrated the ability of this stoker to burn every kind and grade of bituminous coal, as well as sub-bituminous coals and lignite. It has been notably successful in burning the lower-priced poorer grades of coal which are so difficult to burn satisfactorily on other types of stokers.

COMBUSTION ENGINEERING

A MERGER OF COMBUSTION ENGINEERING COMPANY, INC. AND THE SUPERHEATER COMPANY

Choice of industry after industry

Why has the Package Boiler been selected by such widely varying industries as those listed?

BALANCED DESIGN

BECAUSE it has not one or two features for special needs, but a *completely balanced design* that adapts itself to many conditions . . . a design in which each element is coordinated with every other for top performance.

EFFICIENT PERFORMANCE

BECAUSE the C-E Package Boiler has high efficiency over a wide range of output and responds to rapid load swings . . . characteristics especially advantageous in many industrial plants.

EASY OPERATION

BECAUSE the C-E Package Boiler is simple to operate and maintain at peak efficiency — a boon to plants having limited personnel.

CHOICE OF FUELS AND FIRING

BECAUSE in addition to its wide adaptability, the C-E Package Boiler permits you to choose the one *best* method of firing for the fuel and load conditions of *your* plant.

LOWER COST

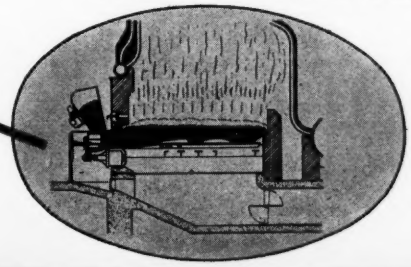
BECAUSE the standardized balanced design of the C-E Package Boiler effects economies in engineering, fabrication, and erection which are passed on to you in lower first cost.

UNIFIED RESPONSIBILITY

BECAUSE the C-E Package Boiler is a complete unit . . . boiler, furnace setting, fuel-burning equipment, controls, forced draft . . . giving you the added benefit of *one contract, one guarantee* and *one responsibility*.

• • •

Small wonder so many diverse industries select the C-E Package Boiler. If your requirements fall within the available capacity range, let C-E engineers match your needs to Package Boiler performance. B-231



TYPE E UNDERFEED STOKER — Designed to burn both caking and non-caking bituminous coals, the Type E Stoker is one of the oldest and best-known stokers in America. Sound design, rugged construction and fine performance have made the Type E Stoker the recognized leader in its field.

PARTIAL LIST OF INDUSTRIES THAT HAVE SELECTED THE C-E PACKAGE BOILER

AUTOMOBILE
BAKERY
CHEMICAL
COLD STORAGE
DAIRY
GLASS
HOSIERY
HOSPITAL
INSTITUTIONS
LEATHER
LINOLEUM
MACHINERY
METALS
OIL
PACKING
PAINTS
PAPER
RAILROADS
RUBBER
STEEL
SUGAR
TEXTILE
TOBACCO
UTILITY

— SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

C-E

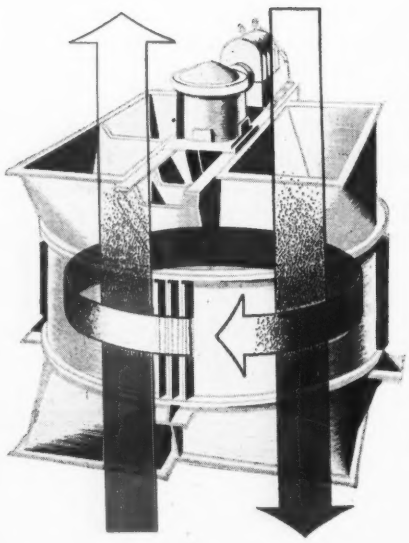
Fact File on Preheat

IN THE LJUNGSTROM, heat is not required to pass *through* the metal and its surface accumulations.

This type of air preheater maintains heat recovery at a *constant level* despite the inevitable surface accumulation of soot and fly ash.

Between cleanings, the surface "as is," acts as an efficient heat storage and transfer medium.

LJUNGSTROM



The Ljungstrom Air Preheater is a compact gas-to-air or gas-to-gas heat exchanger, operating on a continuous regenerative counterflow basis. Hundreds of power plants and other special applications confirm its high level of heat recovery and long-term service at low maintenance expense. Write for engineering details to:

THE

AIR PREHEATER CORPORATION

60 EAST 42ND STREET · NEW YORK 17, N. Y.

Plant: Wellsville, N. Y. 381

CREATING *nothing* TO ASSURE LONG LASTING SERVICE

QUAKER HOSE IS VACUUM "PRE-TESTED" FOR STRENGTH OF WALLS . . . DURABILITY FOR POWER SERVICE

If it has the Quaker trade-mark it must be right . . . each type of hose must meet rigid "pre-tests" before it is shipped for service in the power industry. Scientific pre-tests that subject hose to torture-tests more severe than will ever be encountered in any installation are conducted right in Quaker plants.

One of these steps in "pre-testing" Quaker Hose is shown above. A vacuum test that puts Quaker Hose through the paces to provide rubber products for the power generation field that are second to none in quality.

This is only one of the eighteen rigid tests that raw materials and finished products must pass before receiving the Quaker stamp of approval. Yes, "pre-testing" of Quaker belting, hose and packings provides quality and long service . . . assures worthwhile dividends for your plant through less time-outs for maintenance, higher output, lower operating costs.

PACKINGS THAT PRESERVE POWER

Quaker pump packings are pre-tested for size, shape and quality to assure perfect fit, long service, maximum power.

BELTS THAT BOOST POWER

Quaker's complete line of transmission belting, for every power installation, is pre-tested and service-proved to provide sure-grip . . . slip less . . . save power.

QUAKER RUBBER CORPORATION

PHILADELPHIA 24, PA. • New York 7 • Cleveland 15 • Chicago 16 • Houston 1
Western Territory
QUAKER PACIFIC RUBBER CO • San Francisco 10 • Los Angeles 21 • Seattle 4

QUAKER

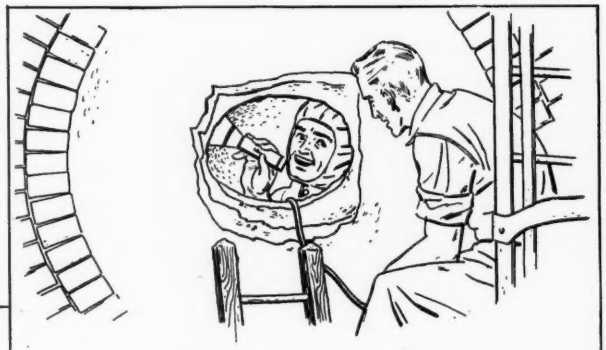
RUBBER PRODUCTS

QUAKER RUBBER CORPORATION
PHILADELPHIA PA
QUALITY SINCE 1885

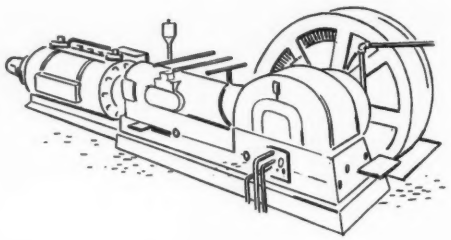
REG. U. S. PAT. OFF.

WHAT SHOULD YOU EXPECT FROM Boiler Water Conditioning?

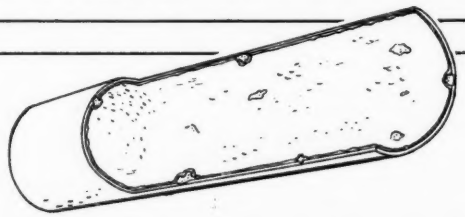
As a boiler plant operator, you have a right to expect that boiler water conditioning will help you in four ways—to keep boilers clean, to provide pure steam, to minimize corrosion, and to reduce the chances of embrittlement. *These four objectives are written into your Hall contract.*



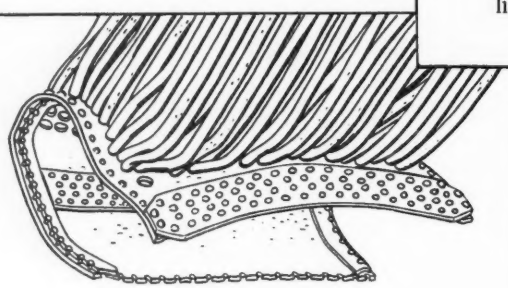
In modern boiler water treatment, chemicals transform scale-forming materials into free-flowing sludge, easily removed in blow-down, thus preventing scale on tube walls. Hall Laboratories discovered how scale really is formed; then how best to prevent it.



Impure steam may be anything from a nuisance to a disaster. Hall service helps you make sure that steam has the purity required for its uses in your plant.



Wherever water is in contact with iron, there is danger of corrosion. Many factors contribute to corrosion, but Hall service will help you to establish conditions which control corrosion.



When boiler metal becomes embrittled, spectacular damage can follow. It isn't common, but it can happen. Hall service helps you avoid conditions which are favorable to embrittlement.

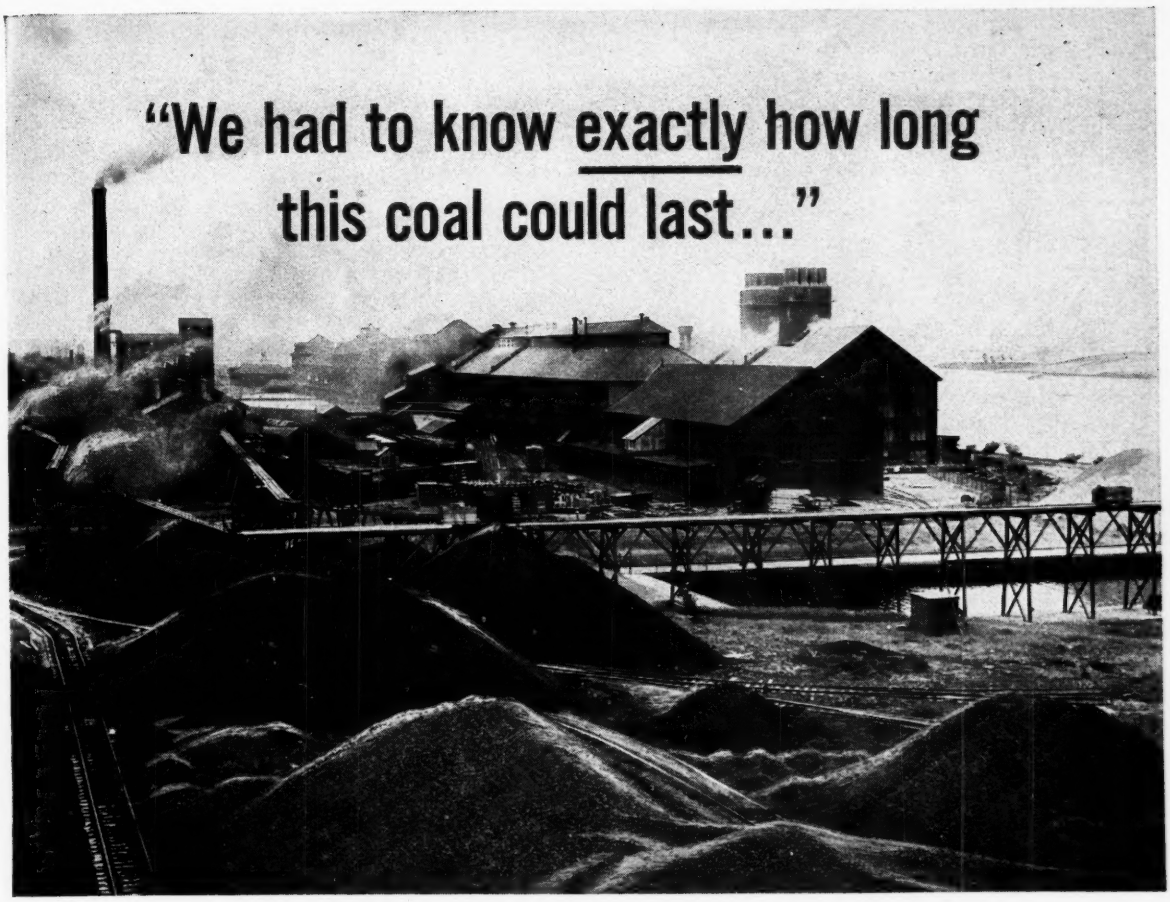
Hall Laboratories serves plants of all sizes, from those which generate less than 1,000 lb./hr. of steam, to those which generate well over 1,000,000 lb./hr. They all find that they can profitably use Hall service.

HALL LABORATORIES, INC.

(A Subsidiary of Hagan Corporation)

Hagan Building, Pittsburgh 30, Pa.

CONSULTANTS ON INDUSTRIAL WATER TREATMENT
HALL SYSTEM OF BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL



"THE REMARKABLE CITIES SERVICE INDUSTRIAL HEAT PROVER TOLD US"

THE INDUSTRIAL HEAT PROVER is an exhaust gas analyzer, designed for use on industrial furnaces regardless of size or type. It is provided with two scales; one shows the percent of oxygen present above the theoretical amount necessary for complete combustion, the other the amount of unburned fuel going into the atmosphere.

"GUESS WORK on coal consumption was a critical problem with us. We had to know, ton-for-ton, exactly how much power we could generate efficiently. When the Cities Service representative demonstrated the Heat Prover, the results were astonishing. This remarkable instrument told us quickly, accurately and continuously how much fuel we needed for maximum efficiency... how much was wasted by needlessly heating excess air... and how we could correct this loss."

If you feel your operation could profit from scientific control of combustion why not get in touch with a Cities Service representative today. Ask for a free demonstration of the Cities Service Industrial Heat Prover.

Free — A new fact-filled booklet entitled "Combustion Control for Industry." Write Cities Service Oil Company, Room 349, Sixty Wall Tower, New York 5, N. Y.

CITIES SERVICE

Bleed steam and condensate piping at new Los Angeles Harbor Steam Plant, Wilmington, Cal.

Piping permanence for City of The Angels

EVERYTHING is big about Los Angeles Department of Water and Power's new Harbor Steam Plant: Per-day sea water consumption, 415 million gallons. Boilers high as eight-story buildings. Turbines weighing approximately 500 tons each.

This investment is being protected by the most durable piping in the world. Welding fittings—*the fittings that become part of the pipe*—are used, and ninety per cent of them are Tube-Turn welding fittings.

Some of the piping would be difficult to get at for maintenance. But there is no maintenance, with the permanently leak-proof welded joints, and with metal structure and strength at least equal to straight pipe in Tube-Turn welding fittings.

Their smoothly functional design permits close nesting, saves space and weight. Smooth inner walls minimize erosion and pressure loss. Dimensional accuracy makes for good alignment, sound welds.

Moral: Only the best is good enough for power piping. And all things considered, the best is the most economical.

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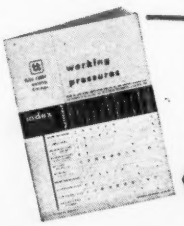
District Offices at New York, Philadelphia, Pittsburgh, Chicago, Houston, San Francisco, Los Angeles



Write for booklet of tables, "Allowable Working Pressures of Tube-Turn Welding Fittings."

TUBE-TURN

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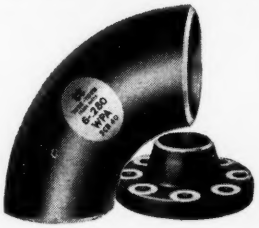
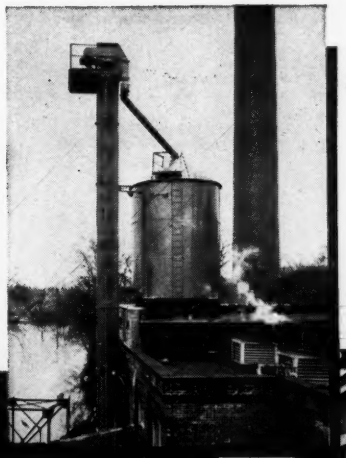
WELDING FITTINGS AND FLANGES

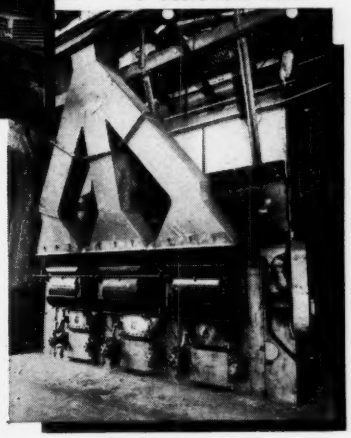


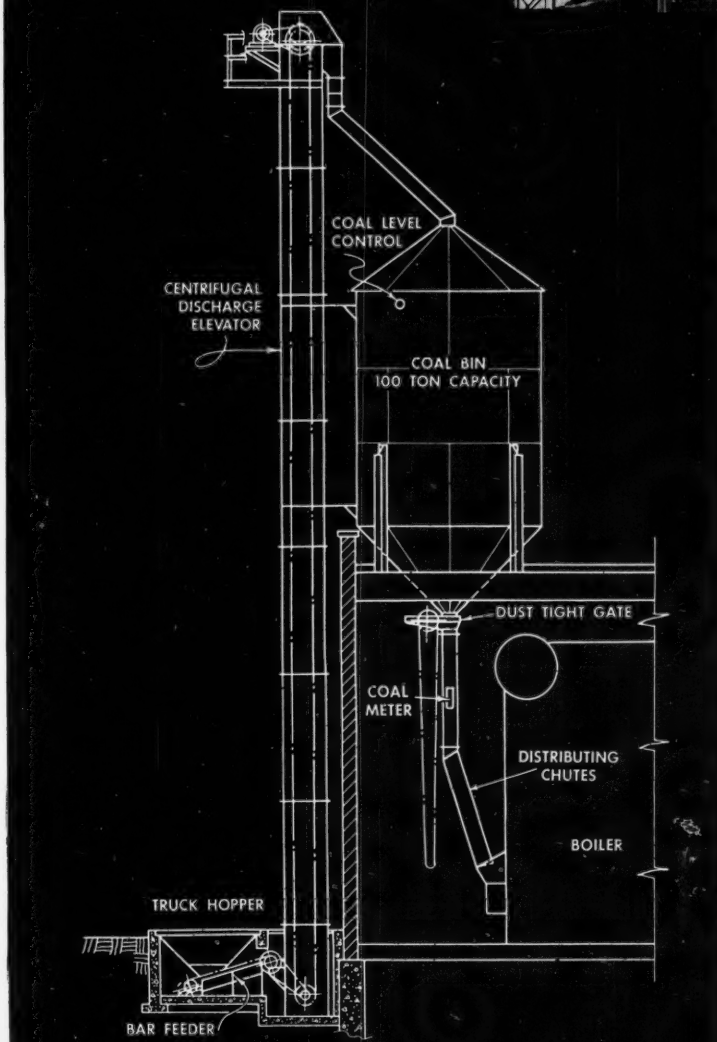
IN THIS CASE
tight quarters saved dollars



G-W Bucket Elevator and Steel Bin on Roof of Braendly Dye Works.

G-W Tri-furcated Distributing Chute Feeding Coal Directly to Stokers from Bin above Boiler Room.





When Braendly Dye Works, Inc., at Beacon, N.Y., modernized their steam boiler plant, a mechanical coal-handling system was required to replace the old, slow manual method. A G-W engineer was called in... recommended the elevator-storage system illustrated.

A river bank restricted ground storage space... a disadvantage that G-W ingenuity converted into economies. A live storage, steel bin was designed and mounted on roof directly over boiler room. Coal is supplied to bin by a bucket elevator and fed continuously by gravity directly to stokers. Warm boiler room air surrounds bottom cone of bin... prevents coal freezing.

Elevator boot is fed by bar type feeder which permits a truck hopper shallow enough to safeguard against flooding when river is high.

G-W took over *this* complete job ... from design through construction and erection...shouldered all responsibilities. G-W's complete engineering service is yours for the asking.

4208-A

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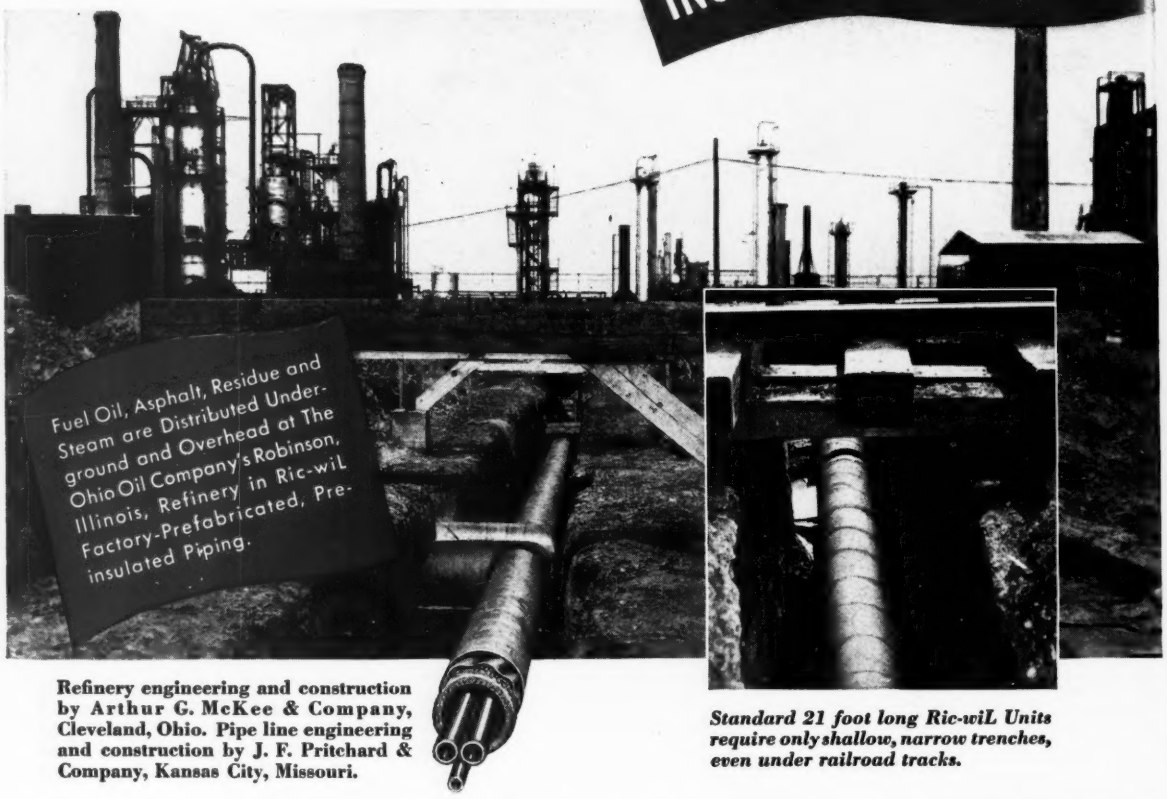
Oil Refinery Meets Diversified Piping Needs with RIC-WIL

INSULATED PIPE UNITS


Fuel Oil, Asphalt, Residue and Steam are Distributed Underground and Overhead at The Ohio Oil Company's Robinson, Illinois, Refinery in Ric-wiL Factory-Prefabricated, Preinsulated Piping.

Refinery engineering and construction by Arthur G. McKee & Company, Cleveland, Ohio. Pipe line engineering and construction by J. F. Pritchard & Company, Kansas City, Missouri.

Standard 21 foot long Ric-wiL Units require only shallow, narrow trenches, even under railroad tracks.

● The adaptability of Ric-wiL Insulated Piping Systems to any type of piping requirement is ably demonstrated by this refinery installation. It consists of ten separate runs of prefabricated pipe units employing a wide variety of pipe sizes and pipe arrangements for distribution of steam and viscous fluids at various temperatures.

The temperatures required for the distribution of the various viscous fluids are efficiently maintained in Ric-wiL Uniline Insulated Pipe Units. In this type of construction, pipes carrying oil, asphalt, etc., are nested with a steam tracer inside an insulation liner which insulates them from the exterior but not from each other.

At Ohio Oil, many different viscous fluids are carried in 4″ and 6″ pipes at temperatures ranging from 125° to 400°F. Steam for tracer lines and processing is distributed in pipes of from 1″ to 6″ diameter at 150 psi, 450°F.

Pipes and insulation are housed in helically corrugated, 16 gauge galvanized ingot iron Hel-coR conduit, ranging from 8″ to 21″ in diameter. The inherent flexibility and strength of this conduit permits underground installation with only 3′-5′ cover, even under heaviest ground loads. Overhead installations require a minimum of scaffolding and supporting structures. Units may be connected on ground before being lowered into trench or erected for overhead suspension. Entire piping systems are delivered completely prefabricated with all accessories—elbows, tees, anchors, expansion loops, etc.—ready for speedy, low cost installation.

Ric-wiL manufactures three basic types of Prefabricated Insulated Piping Systems—Hel-coR, Foilclad and Cast Iron Pipe Units. Pipe, insulation, and protective covering are factory-tailored to individual specifications to meet any condition or requirement for outside piping distribution. For descriptive literature, full information write: The Ric-wiL Company, Department 7-D.

RIC-WIL

INSULATED PIPING SYSTEMS

THE RIC-WIL COMPANY • CLEVELAND, OHIO

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If you're using reciprocating or centrifugal pumps . . .

If your packing seals against fresh or salt, hot or cold water, steam, oil, brine, ammonia or other fluids and chemicals . . .

If you want to know the correct packing for each application . . .

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. . . Then you'll want this new J-M Packing Selector to keep on hand.

This handy new packing selector gives you brief, specific data on ten popular styles of Johns-Manville Packings that serve over 90% of all pump packing applications . . . shows you where to use each style for greatest efficiency and economy of service.

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PG-3

Left—Microphoto of Aerobacter Aerogenes, one of the slime-forming micro-organisms frequently found in water systems, and controlled by the Nalco System. Photos in Nalco Laboratories.

FORMULA FOR SUCCESSFUL SLIME CONTROL

SLIME control in cooling towers, ponds, pipes and equipment requires consistent, careful attention to details. Here is a proven formula for successful slime control which will cut time and cost expenditures to a minimum in your plant:

- Identify slime-forming organisms to be controlled.

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- Locate, by detailed survey, the proper points of application.

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- Determine the best types of treatment to be used.

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- Provide consistent supervision to check application and effectiveness of treatment.

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Nalco Field Representatives and the modern scientific facilities of the Nalco Laboratories are at your service to put this formula for successful slime control into practical operation in your plant. Write for details today.

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HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

ELECTRICAL

101 **Transformer Buyers Guide**—An excellent technical manual on instrument transformers is this 80-page catalog, GEA-4626B. Contains descriptions, photographs and index of ratings and construction for indoor and outdoor potential transformers, indoor and outdoor current transformers, outdoor metering outfits and portable potential and current transformers, according to cycles. Dimensions, prices and shipping weights are included with listing of each type, as is reference to manufacturer's bulletin dealing with that type of transformer. Index of types shows voltage and frequencies. Also included are tables showing mechanical and thermal limits of current transformers. Book has firm covers and ring binding for long-time reference use. General Electric Co.

102 **Induction Motor Bulletin**—A four-page illustrated folder, PB 7000-1, describes manufacturer's new two-pole, 200 to 3500 hp induction motor of fabricated steel construction, available in enclosed or separately ventilated types. Construction features are discussed in detail and illustrated with photographs. Elliott Co.

103 **Synchronous Generators**—This Bulletin 05B6139A, describes construction features and electrical characteristics of engine-type synchronous generators in standard ratings from 25 to 10,000 kva and for standard speeds from 100 to 600 rpm, for Diesel, steam or gas engines. Also describes and illustrates mechanical construction of stators and rotors and discusses machine characteristics, ratings, voltages, frequencies, phases, temperature rises and operation at high elevation. Illustrations show typical installations. Available control accessories are listed, as are manufacturer's other products and territorial sales offices. Allis-Chalmers Manufacturing Co.

104 **Electric Connectors**—A new line of solderless electric connectors is described and illustrated in 36-page Bulletin GEC-400. It contains tables showing comparative sizes of round conductors as well as current ratings of wires and cables, copper tubing and bars, indoor and outdoor switches. Prices of connectors are listed according to class and this listing is preceded by a pictorial index. Photos, diagrams, construction specifications and ordering information are included for each class of connectors. General Electric Co.

105 **Motor Lubrication Bulletin** — This four-page folder describes and illustrates by colored drawings a motor bearing construction feature which permits easy introduction of new lubricant and complete removal of devitalized sludge. Includes cut-away drawings of two types of motors equipped with such bearings. U. S. Electrical Motors Inc.

106 **Magnet Catalog**—Twenty-eight page Catalog CDM-2A is a handy ordering guide for stocked permanent magnets of cast and sintered Alnico and special magnetic alloys. Contains photos, dimensions and pull curves of many stocked magnets and drawings of all stocked patterns. Includes tables showing physical properties and tolerances of cast and sintered Alnico, also conversion table. Outlines procedure for requesting magnet design assistance from manufacturer. General Electric Co.

107 **Generator Bulletin**—This four-page folder describes high-speed synchronous generators for belt drive or direct connection to Diesel engine, or geared to steam turbine. Photographs illustrate discussion of construction features. Mechanical modifications possible with these generators are also illustrated. Elliott Co.

TRAPS AND PIPING

108 **Insulated Pipe Units**—Bulletin No. 4809, eight pages, describes and illustrates prefabricated pipe units suitable for overhead or underground distribution systems for steam, hot water, processing liquids, refrigerants and oils. Cut-away drawings and photographs show construction details and installation advantages. Includes table showing wrought iron and steel pipe sizes available. Also discusses economy of insulated piping. The Ric-Wil Co.

109 **Steam Trap Manual**—"Solving Steam Trap Problems," 36 pages, is both a buyer's guide and reference manual, offering helpful information for anyone called upon to solve steam trap problems. Covers correct trapping practice for unit heaters, jacketed kettled, autoclaves, submerged surfaces, hospital, kitchen and laundry equipment, steam mains, header drips and other units. Tells how to select proper size and detremine lift of trap. Explains theory, operation and maintenance and gives details of simplified piping for steam traps. Also discusses float traps, air release valves and pipe line strainers. Specifications, capacities and some prices are listed. Technical data includes condensate and steam tables. Generously illustrated with photos of traps and installations, sketches and diagrams showing construction and operation. The V. D. Anderson Co.

110 **Pipe Hanger Catalog** — Ninety-page Catalog 10-D is a valuable buyer's guide for adjustable pipe hangers and supports. Covers hangers for attachments to pipe and to structure, hanger assemblies, spring hangers, hanger rods, pipe supports and related equipment. Each type described and illustrated by photo and dimensional diagram and listed with dimensions and prices. Catalog also includes standard specifications, photos of installations and terms of sale. Indexed for quick reference; punched for filing in binder. Grinnell Co., Inc.

111 **Air Dryer Bulletin**—Four-page Bulletin 1500 tells of protection, economy and increased efficiency afforded by air drying units "wherever compressed air or gas is used." Open frame and cabinet models are illustrated, simplicity of operation stressed and capacities listed. Inserted in folder is an inquiry data sheet to facilitate writing for specific information. Dehydraire Division of Davis Engineering Co.

112 **Draining System Bulletin**—Draining and air venting of paper machine cylinders are treated in eight-page Technical Bulletin No. 3. Discusses requirements of an efficient method of draining and air venting dryer rolls and tells how manufacturer's system meets these requirements. Sketches and diagrams show unit and installations. Sarco Co., Inc.

113 **Pipe Units** — Four-page illustrated folder, Form No. 4808, describes prefabricated pipe units insulated and weatherproofed for overhead lines. Photographs show how units are made and packed for shipment and installed for use. Includes three pages of diagrams showing dimensions, general construction and expansion loop and achor details and suggested plans for pole support spacing. Ric-Wil. Co.

114 **Steam Drying Efficiency**—How to Increase the Output of Your Dry Cans" is the title of an eight-page technical bulletin, No. 2, written particularly for the textile industry. Describes and illustrates by sketches ways of increasing efficiency of dry cans. Treats such subjects as mechanical drying by steam, suction dryers, costs, causes of inefficiency. Discusses in detail the manufacturer's system of draining and air venting. Lists information desired by manufacturer for orders. Sarco Co., Inc.

INSTRUMENTS AND CONTROLS

115 **Transformer Test Set**—Bulletin 55, eight pages, describes and illustrates a portable, direct-reading instrument for measuring turn ratio in transformers and checking polarity, tap changer defects, load division and circulating currents. Tells applications of instrument and simplicity of operation, safety features and grounding. Also explains of its hand-cranked A-C generator, low potential excitation and general construction. Refers to instruction manual furnished with set. James G. Biddle Co.

116 **Recording Instruments Data Book**—A new oxygen analyzer—based on the paramagnetic property of oxygen—is introduced by description and illustration in Bulletin 48-829, 16 pages. Tells advantages and applications of new instrument. Also treats in detail the manufacturer's long-established analyzer for carbon dioxide and other gases, as well as an electronic recorder (which records temperature and pressure, too) for use with the analyzers. Includes discussion of several recommended gas sampling systems. The Hays Corp.

117 **Multiple Signal and Alarm Systems** —Panalarms, multiple signal and alarm systems adaptable to all types of industrial and power plant applications, are described in 12-page, letter-size, illustrated Series 300 Panalarm bulletin. Gives details of operation, shows types for panel and well mounting, wiring circuits, operation sequence, dimensions of units, Shows how Panalarms indicate by light and horn signals, acknowledging button, for normal and abnormal conditions. Systems are supplied in multiple units up to 12 in single cabinet; extra space for spare units; provisions for future additions; simple field wiring. Panalarm Products, Inc.

118 **Feed Controls**—Bulletin No. 149-2, four pages, describes and illustrates constant feed controls adaptable to manufacturer's own hammer mills. Operation of mill and control is pictured by cut-away drawing, showing how suspension grinding is possble with this equipment. Stresses economy afforded by feed controls and quotes letters from engineers who have

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MARCH, 1949

POWER GENERATION

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installed them. J. B. Sedberry, Inc.

119 **Water Gages** — Eight-page Bulletin E-1 covers line of water gages for stationary and locomotive boilers, marine and refinery service and tanks for all pressures and temperatures. Listings include photos of all gages, sizes and construction details. Bulletin S-2, four pages, covers gage glasses, glass guards, sight flow indicators and related equipment. Ernst Water Column & Gage Co.

PUMPS

120 **Centrifugal Pumps**—Bulletin W-318-B73 is a 12-page technical catalog covering specifications, types, services and dimensions of axially and radially balanced multi-stage volute centrifugal pumps for boiler feed service. Clearly illustrated with photographs of models and cross section sketches showing principles of construction and operation. Bulletin is punched for filing in binder. Worthington Pump and Machinery Corp.

121 **Pump Bulletin**—No. 488, four pages, tells about controlled volume chemical pumps with rotary air or gas motor drives for pumping in small volume or at high pressures, or handling difficult or corrosive materials. Discusses motor feed systems, stroke adjustments and merits of special valve construction, illustrated by cut-away drawing. Technical information capacity pressure selection table and diagrams showing pump installation and automatic pH control system. Milton Roy Co.

122 **Oil Pump Bulletin** — Twelve-page Bulletin No. PM-48 presents engineering data on self-priming centrifugal pumps for petroleum and other volatile liquids. Discusses and illustrates construction features and advantages and gives general information on pump installation. Technical data includes selection charts and specification tables for engine-driven and electric motor-driven pumps, specific gravity and viscosity tables, and tables showing liquid head equivalents, maximum suction lifts at sea level, atmospheric conditions, friction loss in liquid in steel pipe and fittings, and loss in pounds pressure per 100 ft of smooth bore rubber hose. Marlow Pumps.

123 **Multi-Stage Pumps** — Bulletin No. 48-4000, 16 pages, covers centrifugal, multi-stage, split case, volute type pumps for medium and high pressure service. Descriptions are illustrated by photos showing construction features and by sectional drawings. Includes tables of dimensions, list of service applications of different models and photographs of an installation. Byron Jackson Co.

124 **Proportioning Feed Pumps Manual**—Bulletin No. 1100, 16 pages, describes and illustrates the application of chemical feeding and proportioning pumps designed for use in almost every industry and available in standard and midget sizes for pressures up to 6000 psig. Contains photos of models and diagrams showing dimensions, sectional views and industrial applications. Also includes a capacity schedule table, photos and descriptions of available accessories and discussion of variations in construction to suit specific requirements. Typical boiler water conditioning systems are illustrated. Proportioneers, Inc.

125 **Turbo Pump Bulletin** — Four-page illustrated folder deals with two popular types of high-speed, single stage turbo pumps. Lists typical services and boiler feed ratings. Detailed discussion of outstanding features is accompanied by cross-section drawings showing operating principles of pumps and governing gear. Also lists other types of pumps and control valve and outlines data need for inquiries. The J. S. Coffin, Jr., Co.

TREATMENTS

126 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-page technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater systems. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. Illustrations include photographs of two feeders and diagrams of the various methods described. Punched for filing in ring binder. Proportioneers, Inc.

127 **Corrosion Preventive**—Bulletin 1540, four pages, describes a corrosion-resistant protective coating for cold, wet steel surfaces and discusses its uses on water storage tanks, refrigerant condensers, air conditioning equipment and equipment aboard ship. Tells how to order coating and how to apply it and illustrates, by photos, available application equipment. The Dampney Co. of America.

128 **Water Conditioning Bulletin**—This is an eight-page discussion of water and chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also discusses special purpose chemicals. Wright Chemical Corp.

129 **Chlorinator Catalog** — Dry vacuum chlorine dispensing units for purifying drinking water supplies, for treatment of sewage and for treatment of condenser water in industrial and power plants are described and illustrated in 16-page Catalog Section 61. Tells advantages of unit, discusses assembling and mounting, recording instruments and automatic proportioning. Chlorine filter pressure gage, chlorine flow measurement and adjustment, vacuum regulator and water check and method of operation are described in detail and illustrated. Also described is dry gas feed type of dispenser. Includes capacities, dimensions and diagrammatic layouts. Fischer & Porter Co.

130 **Chemical Proportioning Literature**—This four-page catalog lists 37 available bulletins and reprints of articles published by manufacturer on general subject of constant rate and flow responsive chemical proportioning. Material listed covers equipment, methods and applications. Proportioneers, Inc.

MISCELLANEOUS

131 **Evaporator Evolution** — The manufacturer devotes the Jan. 1949, issue of its periodical to an interesting, historical survey of evaporators for the distillation of water. It traces their development from mention of them in voyage diaries back as far as 1593 and in early recorded experiments of scientists. Illustrations of the manufacturer's models from 1867 show successive improvements in design leading to those now built for power generating stations, industrial plants and ships. Also included are detailed photographs of present-day evaporator elements. The Griscom-Russell Co.

132 **Automatic Oil Burner**—Bulletin 400, four pages, describes automatic burner shipped as complete factory-built unit, ready for service connections on oil burning system for all types of boilers and furnaces from 100 developed hp. Explains economy, dependability and ease of installation of this compact burner. Description of construction is illustrated by front and side view photos, showing control cabinet and accessibility of parts. Lists specifications of both fully-automatic and semi-automatic types. Also includes pictures of manufacturer's other equipment. Peabody Manufacturing Corp.

133 **Mechanical Draft Fans**—Buletin No. 168, 20 pages, covers manufacturer's line of specially designed mechanical draft fans. Tells characteristics of principal blade types and discusses volume control, dampers, vanes, shafts, bearings, housings, inlet boxes, scroll and blade liners, duplex and stack supporting fans, also balancing and rating. Lists some typical installations in various industries. Sketches show standard designations of rotation and discharge and of inlet box position, and standard arrangement of drive. Illustrations include diagrams showing construction and operation of fans, efficiency graphs and many photos of parts, full models and installations. The Green Fuel Economizer Co., Inc.

134 **Silicone Rubber**—Factual information about Silicone Rubber is presented in a 24-page catalog. Discusses development of this new synthetic, its chemical and electrical properties, resistance to heat and cold and suitability for use with solvents. Descriptions of individual products are accompanied by photos of product itself and industrial application. Book also includes property tables for quick reference and ordering information and tells technical services offered. General Electric Co.

135 **Soldering Manual** — "Solder and Soldering Technique" is the title of a 28-page technical manual devoted largely to the use of soft solder alloys and soldering fluxes. Solder wire, preforms and related products are discussed and technical services offered by manufacturer are listed. Tables showing melting points of common solder alloys and length in feed per pound of solid wire solder are included. Kester Solder Co.

136 **Automatic Defrosting System**—Complete details of a hot gas "slug eliminator" defrosting system are given in a four-page, four-color bulletin, No. DF-100. Simplified diagrams in several colors show operation at various stages in the defrosting cycle of a two-evaporator refrigeration system, and a description of the operating principle accompanies the diagrams. Bulletin also discusses installation of slug eliminator in existing refrigeration systems and tells of specialized services offered by company's engineering department. The Patterson-Kelley Co., Inc.

137 **Zipper Conveyors**—Bulletin 344, eight pages, is devoted to a description of a new zipper conveyor elevator, its construction, operation and applications. Sketches show how continuous zipper fastening on flexible belt permits bulky material to be enclosed within belt itself and carried in any direction on any plane. Other sketches show typical conveyor arrangements and there are photos of these conveyors in use. Also included are clear, concise answers to questions most frequently asked about zipper conveyor. Stephens-Adamson Manufacturing Co.

138 **Adhesive Reference Manual**—This 16 page illustrated manual covers sealers, surface coatings, cements, mastics, emulsions and other adhesives for wide industrial and marine application. Contains detailed discussion of viscosity, coverage, flammability, heat flow and resistance to acids and alkalis. For quick reference there's a chart summarizing bonding and drying times, colors, temperature limits, types of thinner indicated and other pertinent information about each adhesive. Manual is punched for permanent use in ring binder and includes additional data sheets on adhesives not covered in the manual itself which may be filed with it. Sketches and photographs show products in use. Benjamin Foster Co.

139 **Floor Resurfacing**—Step-by-step directions for applying a heavy duty concrete floor resurfacer for patching and for large floor areas are given in an illustrated folder, four pages. Tells composition, uses and advantages of the resurfacer and approximate coverage. Related products of manufacturer are also listed. Flexrock Co.

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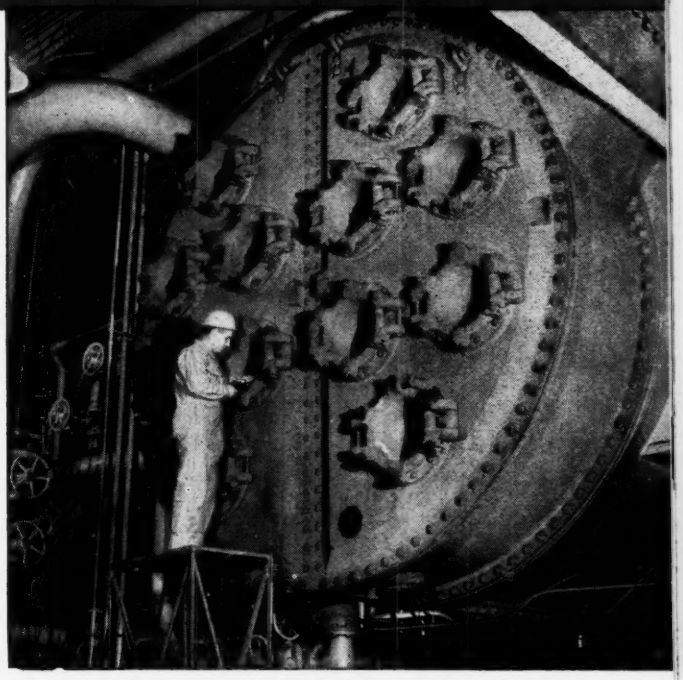

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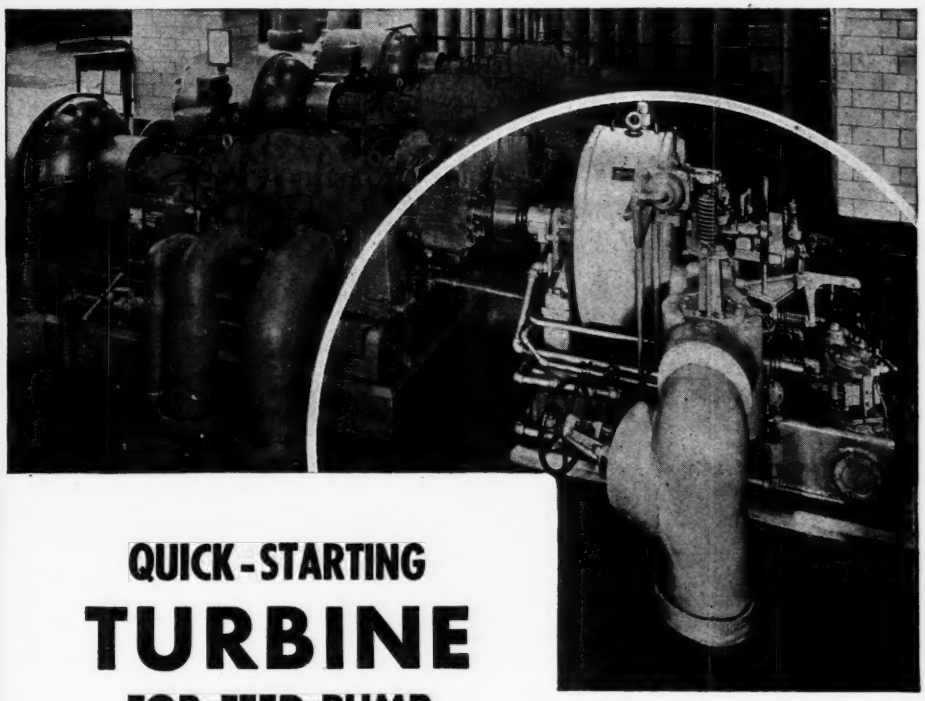

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The turbine shown at the right picks up the feed-pump load in case the motor, which normally drives the unit, is inoperative. Thus the turbine must be able to start quickly and be completely reliable —characteristics which are assured by the generous blade clearances and one-piece construction of the Terry Wheel.

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DATA

The turbine is 620 hp, 3550 rpm for 850 psi, 900F steam with 2.5 psi back pressure.

Installed in the Crawford station, Middletown, Pa., Metropolitan Edison Co. Gilbert Associates, Inc. were the consulting engineers.

T-1178

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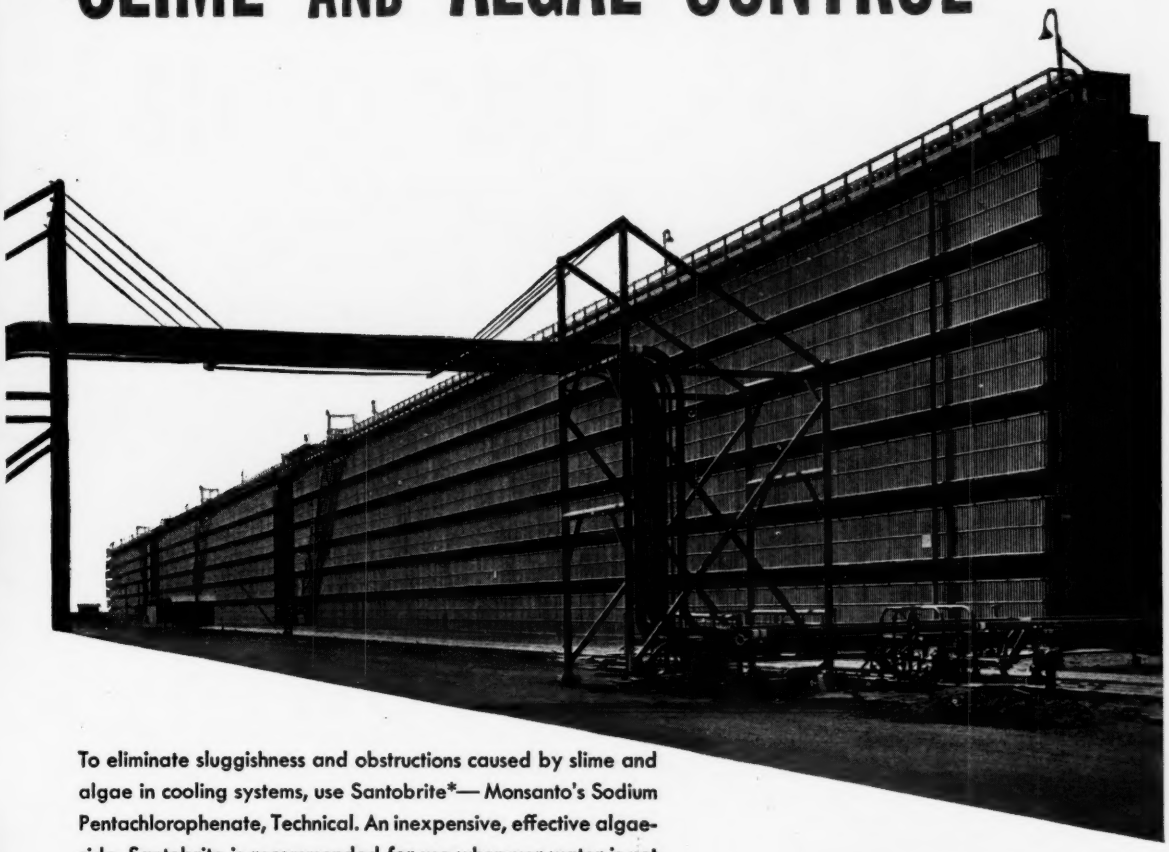

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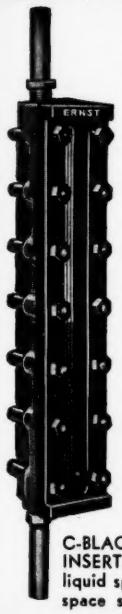

Fig. 37

C-BLACK PRISMATIC FLAT GLASS INSERT. Gives a clear Sharp Vision, liquid space shows BLACK and the steam space shows WHITE.

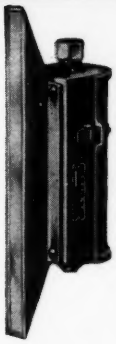

Fig. 10

Plain Sight Non-Glare Illuminator furnished with 12" or 18" slot for Improved vision.

Fig. 31

Ernst Plastic Glass Guard, with Replaceable plates. This guard can be made in any length or size.

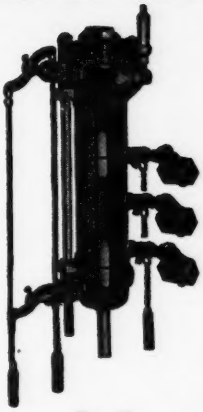

Fig. 83

No. 5 high and low alarm column with vertical gages and DCP weighted type try cocks.

Fig. 45

Illustrates C-Clear Thru Mica Protected Flat Glass Insert. This Insert is Mica lined for protection of glass.

SIGHT FLOW INDICATORS FOR INSERTION INTO PIPE LINES

Fig. E-57

double window

iron construction

size of conn.	A	C
¾"	4"	1⅝"
1"	4¼"	1¾"
1¼"	4½"	1¾"
1½"	4¾"	1¾"
2"	6¾"	2⅛"
2½"	6¾"	2⅛"
3"	7¼"	2⅛"

glasses: Heavy plate and heat-resisting

Fig. 17-28

With Impeller
Fig. 29

For insertion into pipe lines. Bronze or iron frame construction with standard iron pipe threads. Male or female end connections. Furnished with impeller or without impeller, in standard sizes: Connection—⅜" to 4"; O.D. glass—1" to 5"; length glass—2¾" to 5".

Fig. E-811

single window, flapper type

bronze construction

size of conn.	A	C
⅜"	3"	1⅝"
½"	3"	1⅝"
¾"	3¾"	2"
1"	3¾"	2"
1¼"	4¾"	2¾"
1½"	4¾"	2¾"
2"	6½"	3⅛"
2½"	6½"	3⅛"
3"	7⅝"	2¾"
4"	10"	2¾"

glasses: Heavy plate and heat-resisting

HIGH PRESSURE GAGE GLASSES
AND SERIES 750 COMPOSITION GAGE GLASS GASKETS

FLAT TYPE REFLEX AND CLEAR

CLEAR AND RED-LINE MAGNIFYING TYPE

Fig. 22

Fig. 21

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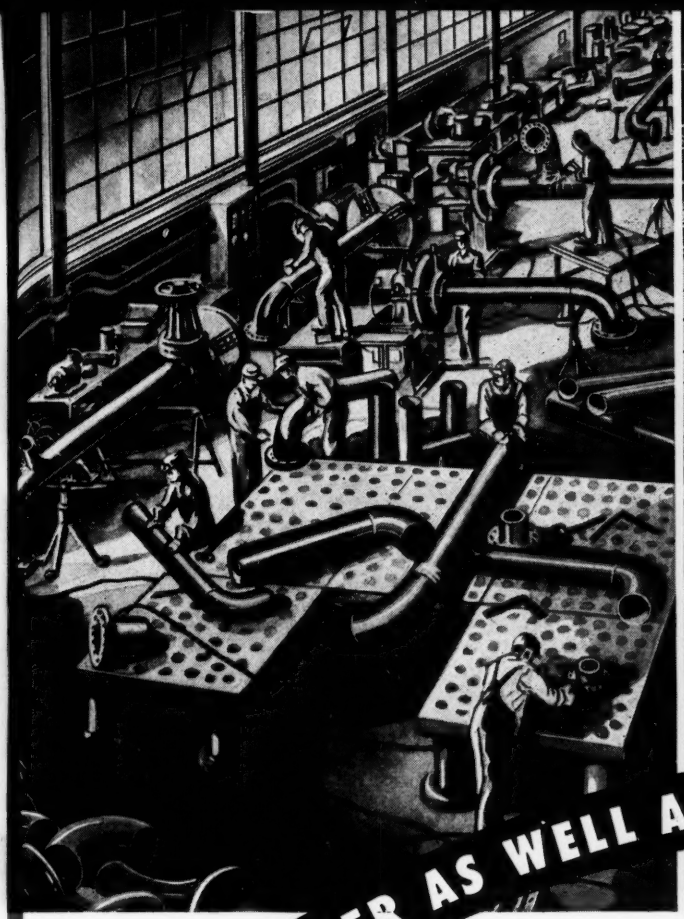

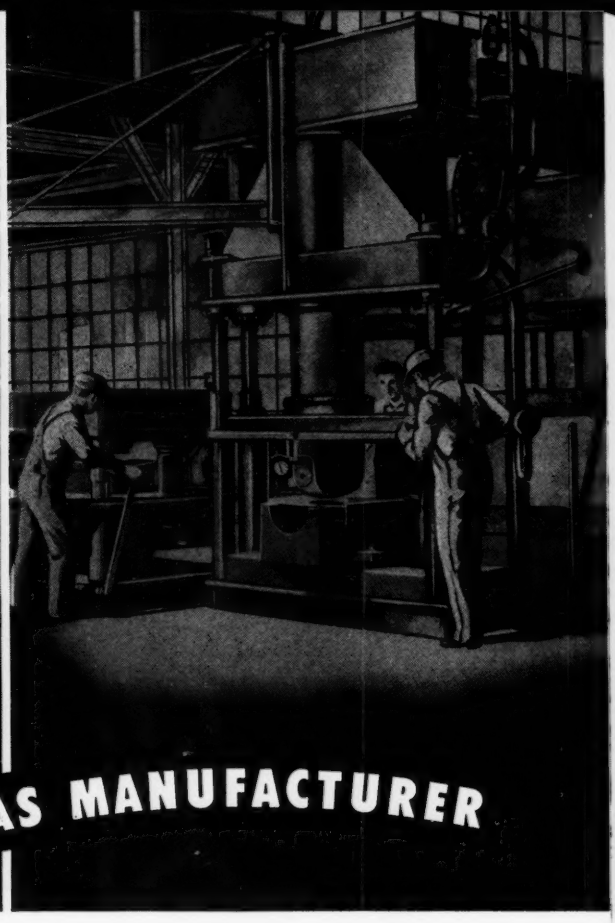

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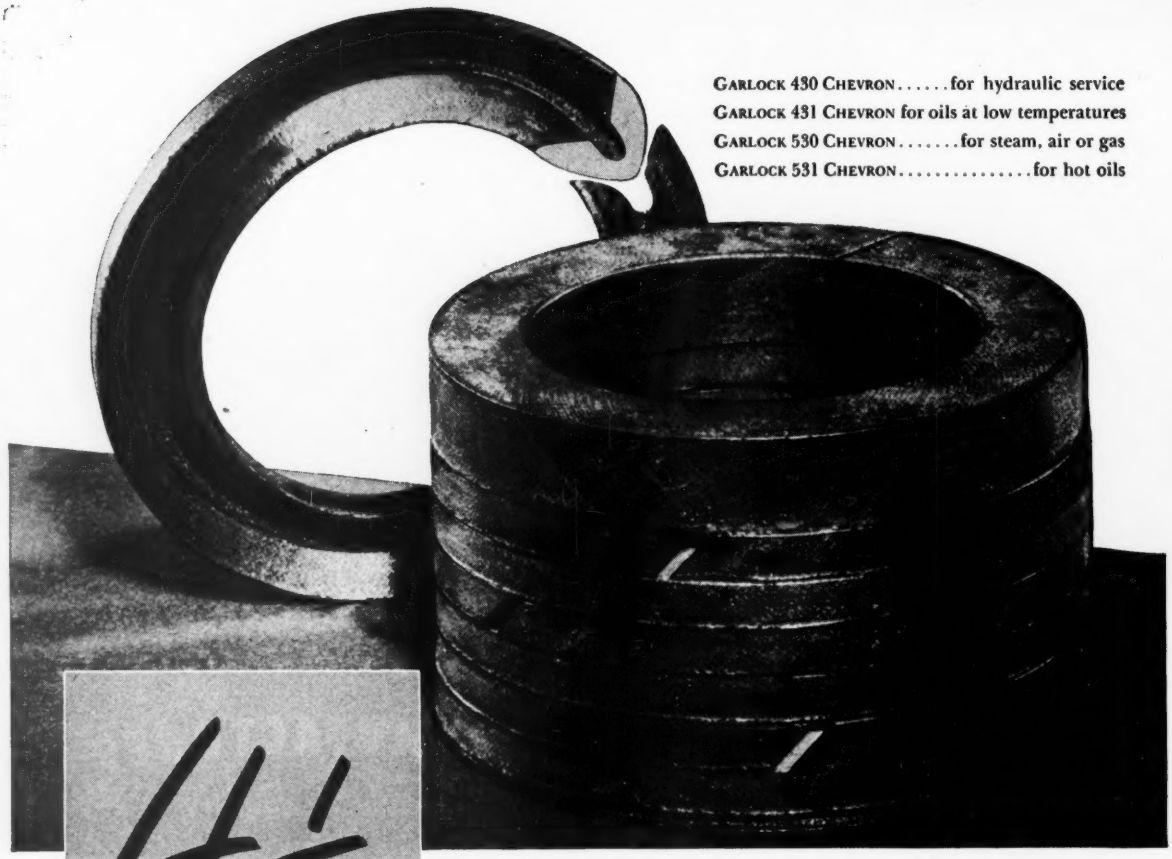

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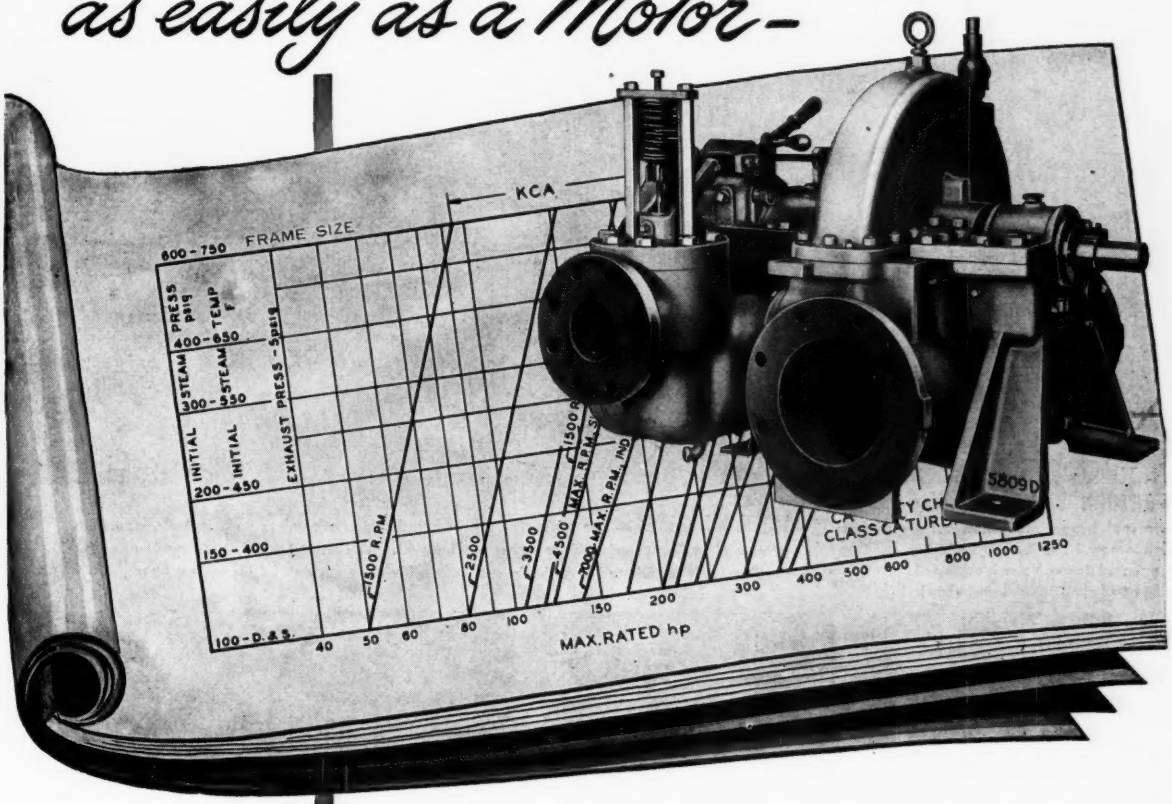

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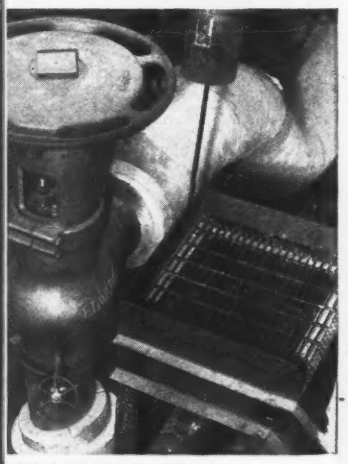
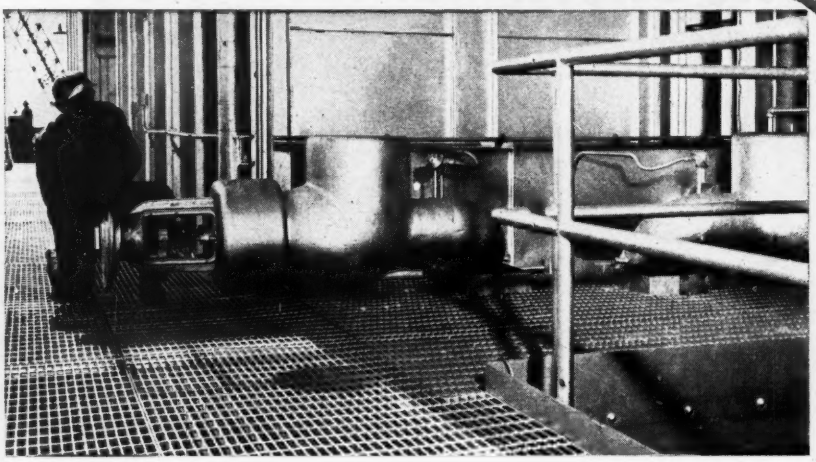
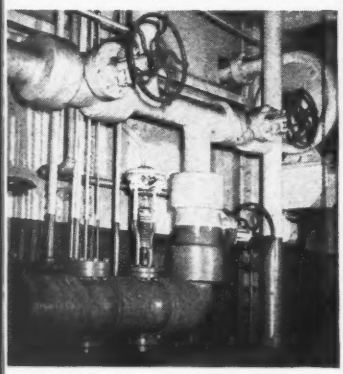


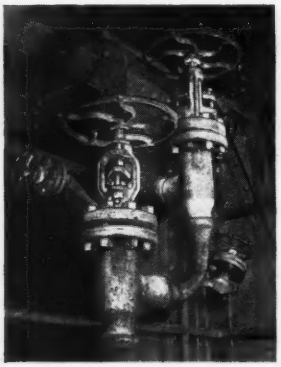
NON-RETURN VALVES—Edward pressure-seal bonnet non-return valve installed in new 1300 lb, 950 F middle western central station. Valve is equipped with Edward Impactor handwheel.



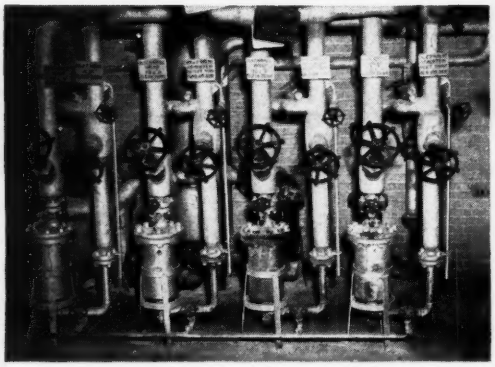
FEEDLINE VALVES—Two separated type Edward stop-check valves on 5 in. boiler feedlines of new West Coast semi-outdoor power plant. By all odds the most widely used steel valves for feedline service, Edward stop-checks are built in both screwdown and separated type.



GATE VALVES—Edward 600 lb gate valves, with ball bearing yokes and welded in hard-faced seats, in modern power plant of major point manufacturer.

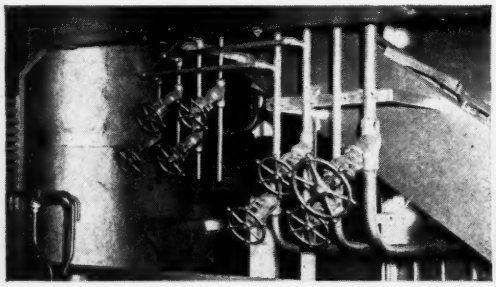


BLOW-OFF VALVES—Interesting piping arrangement of 1500 lb Edward blow-off valves in famous North Central area generating station.



FORGED STEL VALVES—A variety of sizes of Edward Fig. 2688 valves on trap lines of large central station, located in the northwestern area.

Edward builds the world's most complete line of steel power plant valves—gate, globe and angle stop, non-return, check, feedline stop-check, blow-off, Intex, Univalve, gage, hydraulic, relief valves and strainers for service from 150 to 7500 lb with bolted, screwed, welded or pressure-seal bonnet connections and with flanged, screwed or welding end connections. Write for catalogs.



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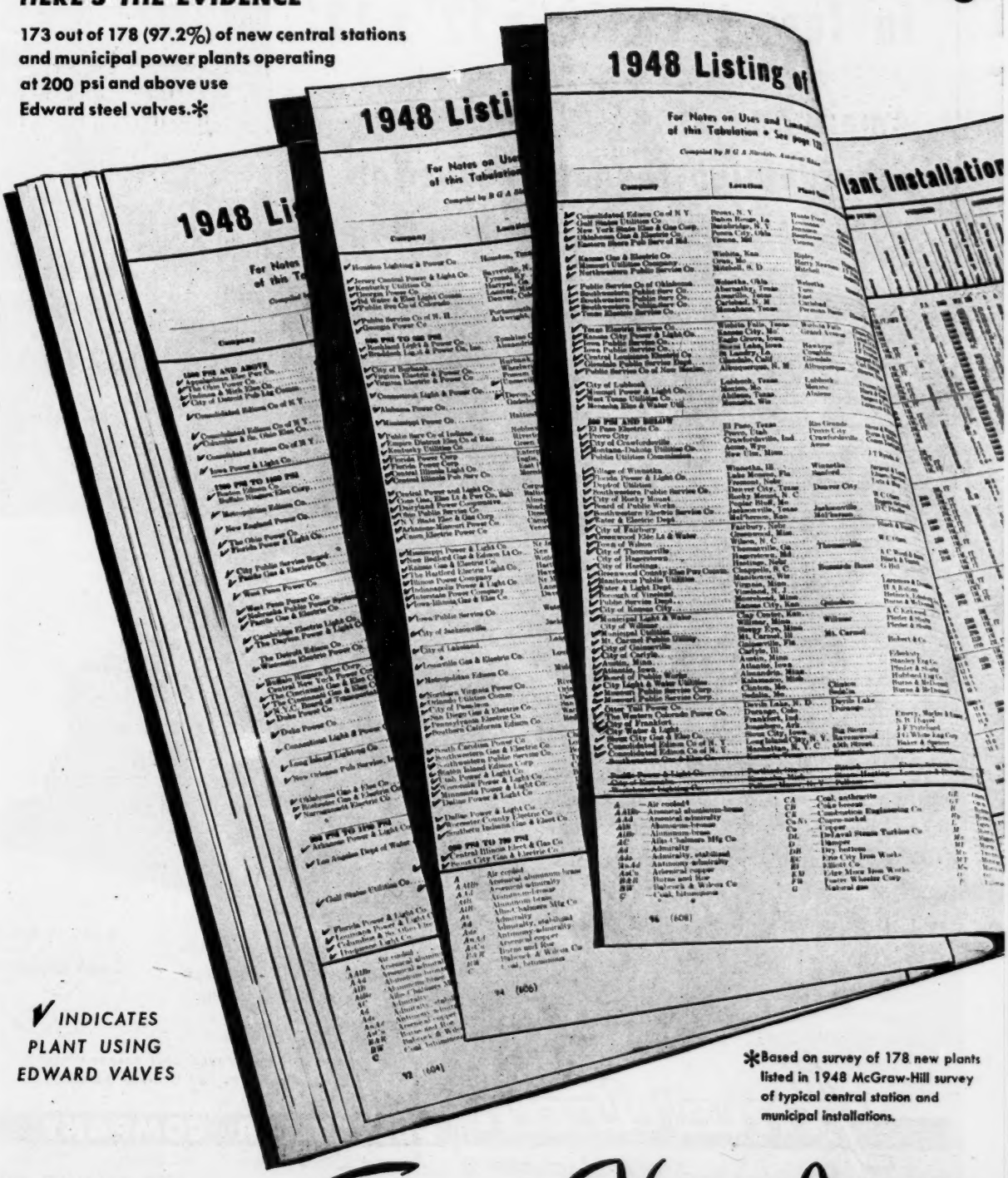

✓ INDICATES PLANT USING EDWARD VALVES

*Based on survey of 178 new plants listed in 1948 McGraw-Hill survey of typical central station and municipal installations.

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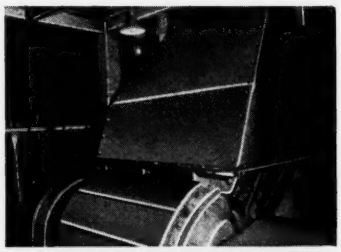
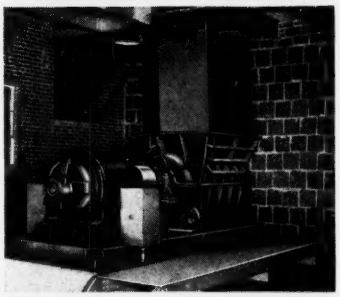
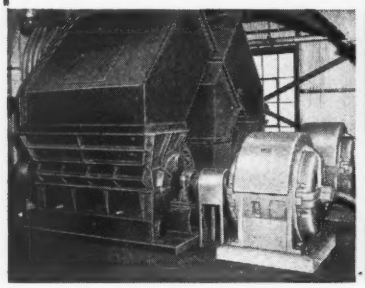
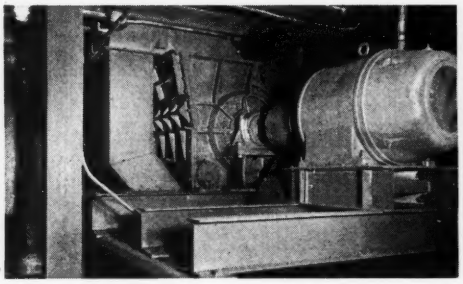
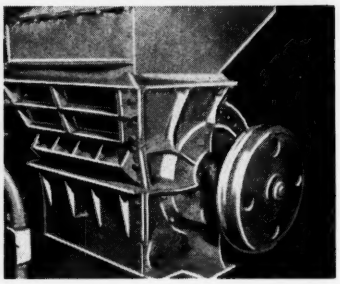


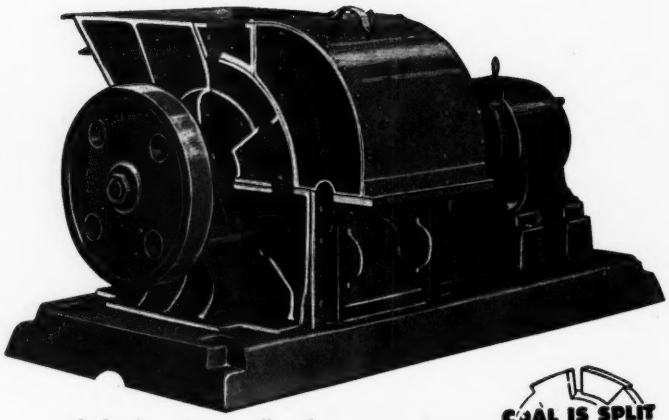








Americans are contributing to greater firing efficiency in power plants everywhere. ROM coal is rapidly reduced to stoker or pulverizing sizes in one low-cost operation. A complete, compact crushing operation requiring only minimum headroom and no auxiliary crushing or breaking units. Americans incur little or no extensive plant alterations. American Rolling Ring Crushers are built in capacities up to 500 TPH.



Only Americans offer the patented shredder ring action that *splits coal* by efficient cleavage action of multiple cutting edges.

COAL IS SPLIT -NOT CRUSHED

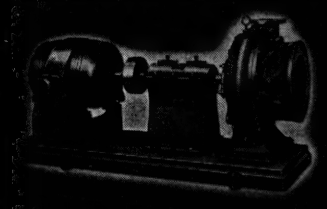
Get the data on improved coal preparation— Send for Americans "S" Crusher Bulletin.

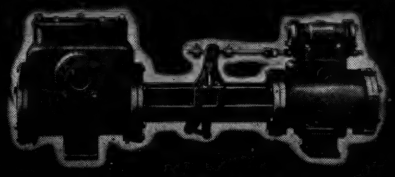
American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1429 MACKLIND AVE.
ST. LOUIS 10, MO.

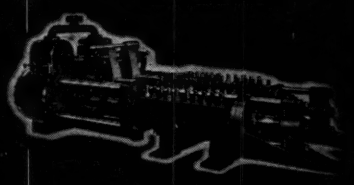
Warren Stock Pump
Type 5-SOD-15 . . . 12" suction nozzle





Warren Steam Heat
Vacuum Pump

Warren Horizontal Duplex
Hydraulic Pump



WARREN PUMPS

Maintain efficiency
Operate at low cost
Are long-lived

CENTRIFUGAL

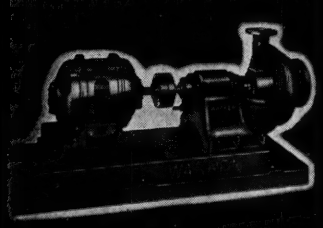
Single and multi-stage
Pressure range: 0 to 1200 P. S. I.
Capacities: 0 to 50,000 G. P. M.
Types: Horizontal and Vertical
Impellers: Open or enclosed
Casings: Horizontal or Vertical Split, cast iron or bronze
Bearings: Sleeve or ball-bearing

RECIPROCATING

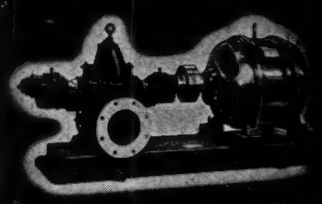
Horizontal and Vertical single piston
Horizontal and Vertical duplex piston
Single and Duplex Outside Packed Plunger
Single, Duplex and Compound Hydraulic Steam Heat Vacuum
Automatic Pump and Receiver, etc., etc.,

Send your pumping problem to us; our Engineers will recommend the right pump for the job.

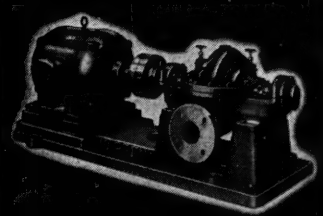
P 14



Warren Type "L" Single-Stage
Single-Suction Liquor Pump



Warren Double Suction Pump
Single Stage



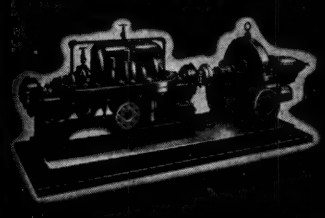
Warren Type DBL, Single-Stage
Double Suction, Centrifugal Pump

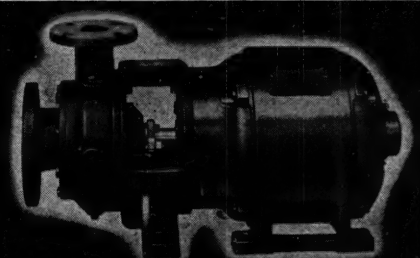
Warren Two-Stage Volute
Centrifugal Pump

WARREN STEAM PUMP COMPANY, INC.

WARREN, MASSACHUSETTS

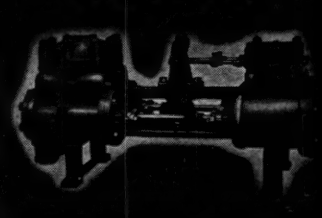
Warren Type TM, 4 and 6 Stage
Centrifugal Pump





Warren "Compacunit"—4 Types—42 Sizes

Warren Horizontal "Realwear"
Duplex Piston Pump

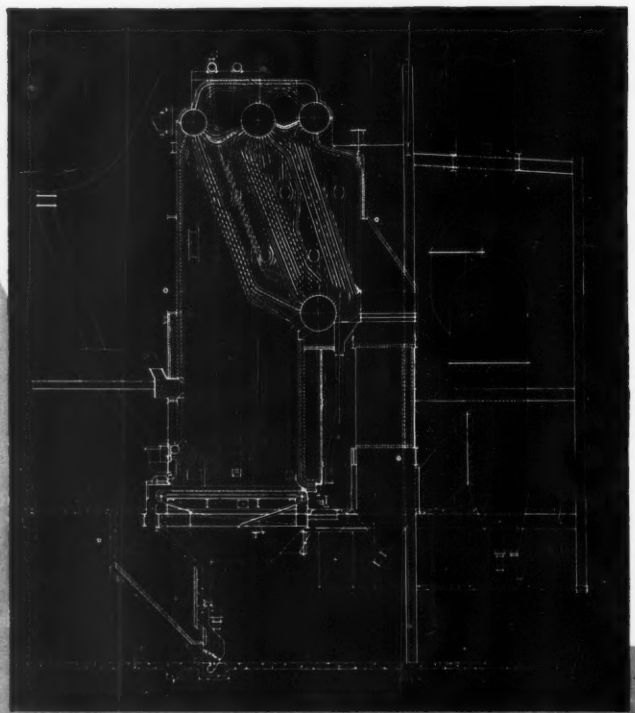


J&L STEEL Chooses DETROIT ROTOGRATE STOKERS

FOR NEW MILLION POUND STEAM PLANT

Jones & Laughlin Steel Corporation, Pittsburgh, selected Detroit RotoGrate Stokers for their new steam plant.

The five units for this plant will have a total maximum capacity of 1,000,000 pounds of steam per hour. They replace 43 smaller boilers now in service in four separate locations at their "Pittsburgh Works".



RotoGrates applied to four drum units designed for 300 degrees F. preheat.

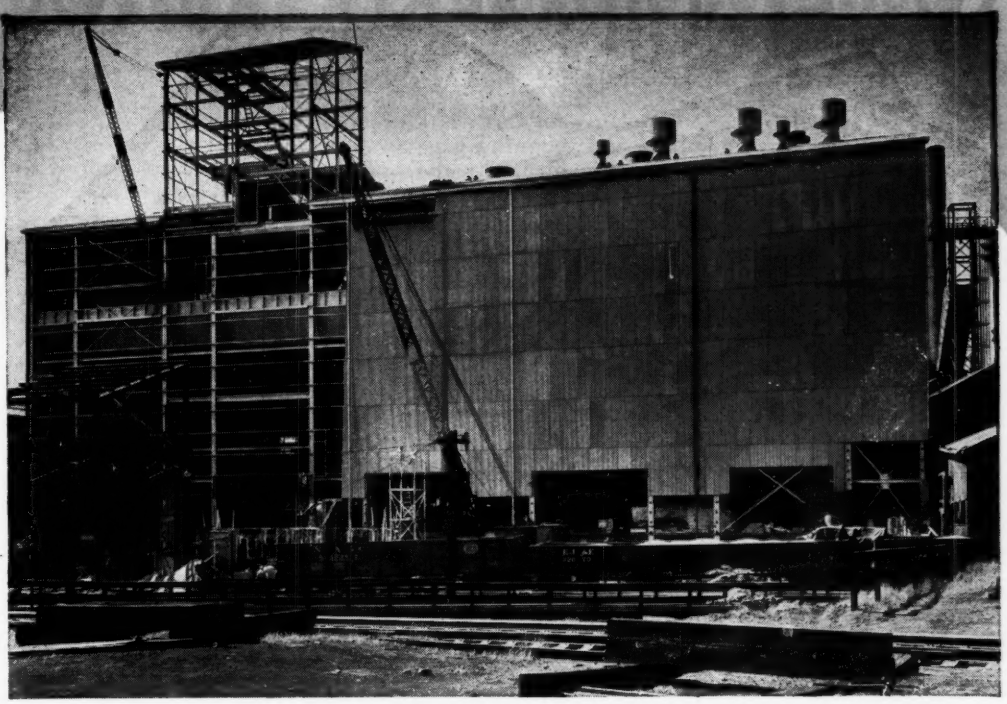
The RotoGrate Stoker has met the most exacting requirements in all types of plants. A spreader stoker with forward moving grates that discharge the ash at the front. Burns any Bituminous Coal or Lignite with high efficiency.

Write for the RotoGrate

BULLETIN

No obligation

OTHER TYPES AND SIZES OF DETROIT STOKERS FOR EVERY INDUSTRIAL OR POWER NEED.



Construction view of new 4½ million dollar J. & L. Boiler Plant on the South Side of Pittsburgh.

Professor Sumner B. Ely, Superintendent of the Pittsburgh Smoke Prevention Bureau, lights the first RotoGrate in the presence of J. & L. officials.

DETROIT SINCE 1898 STOKERS

DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

WORKS AT MONROE, MICHIGAN • DISTRICT OFFICES IN PRINCIPAL CITIES

NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Generation, 53 West Jackson Boulevard, Chicago 4, Illinois

1—DRAWOUT RELAY

Is designed for simplified installation, easy maintenance

This drawout relay unit is suitable for either semiflush or surface mounting, and comes with an assortment of hardware providing for any type of mounting, and either threaded-stud or washerhead-screw connection. The cover attaches to the case, so that relay unit can be removed and cover replaced, thus preventing accumulation of dust within case or accidental contact with exposed circuit elements.

Cover screws are self-centering and easy to start, and each screw has provision for sealing wire.

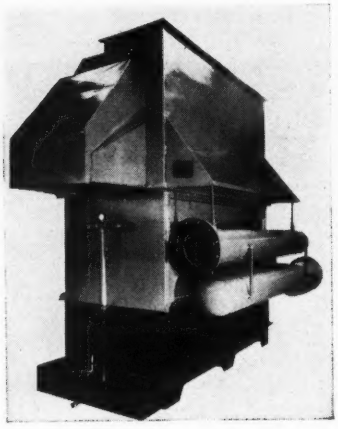
In addition, a large felt gasket that improves seal against dust is recessed within the cover, and therefore protected from damage by handling. It is hidden when the cover is in place. Maintenance is also improved by simplification of the drawout unit, thus providing greater accessibility to the relay components.

Screws for semiflush mountings are inserted from the back of the panel into the threaded bosses on the mounting flange, so that the cover protects and conceals them. The reset button is carried entirely within the cover, and makes smooth and positive direct connection with the reset lever of the target. General Electric Co.

2—AFTER COOLER

Protected against freezing; uses less cooling water

This equipment called the Aero After Cooler dehydrates compressed air or gas by cooling it below the dry bulb temperature of the atmospheric air, thereby removing the moisture that condenses at that point and preventing further condensation of water in air or gas lines in use. This is done by evaporating a recirculating water spray on the surface of a coil through which compressed air passes, creating a temperature close to wet bulb temperature



of surrounding atmosphere, and lower than dry bulb temperature and also below the summer surface water temperature.

Protection against freezing is provided by "balanced-wet-bulb" control. A thermostat in spray water reservoir is set for desired low temperature limit at which it operates dampers to recirculate the air steam internally around a division plate in the center of the unit—instead of drawing in freezing air. This permits outdoor installations to save space and give the benefit of lowest wet bulb temperature in summer, and provide cleaner air for easier maintenance. This after cooler is said to consume less than 5 per cent of the cooling water required by most coolers. Prevention of condensation in air lines saves water damage to air tools, paint sprays or materials in process. Niagara Blower Co.

3—UNIT HEATER

Smaller sized, for use in limited areas, with automatic features

Now available is a new Thermobloc Model 300, direct-fired unit heater with characteristics exactly like those of an existing model, except for size and output. This new unit is only 7 ft high and 30 in. diameter with an output of 300,000 Btu compared to 10 ft high and 550,000 Btu for the larger model. Like the larger unit, this one is completely packaged, with only the fuel, electrical and flue connections necessary to place it in operation. Its small diameter permits installation in limited areas without interference with the operating area.

Heated air from the Thermobloc 300 is delivered directly to the working

area without excessive velocity. Waste, normally encountered in systems that heat from the ceiling down, is minimized. These, and many other features, offer savings in heating, compared to other methods. Completely automatic features of this heater permit independent operation and accurate adjustment to heating needs. Described as being ideal as dryer, or for circulating

MARCH, 1949

POWER GENERATION

53 W. Jackson Blvd.
Chicago, Ill.

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It's CRANE for complete selection for any power piping

For steam, water, oil or gas lines—in short, for any fluid or working condition, there's no more reliable source than Crane for quality piping equipment. One catalog gives you quick and easy selection from the world's most complete line of valves, fittings, pipe and accessories. One order results in fast, modern service from local, well-stocked Crane Branches and Wholesalers.

This Desuperheater and Oil Cooler piping, for example, typifies the unequaled selection you get from Crane. To depend on this **Single Source of Supply** for every item is to simplify all piping procedures, from design to erection to maintenance. **One Responsibility** for materials gives you better installations, avoids delays on the job. **One Standard of Quality**—when it's Crane Quality—helps you to realize the utmost in dependable performance from every part of every piping system.

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ONE SOURCE OF SUPPLY
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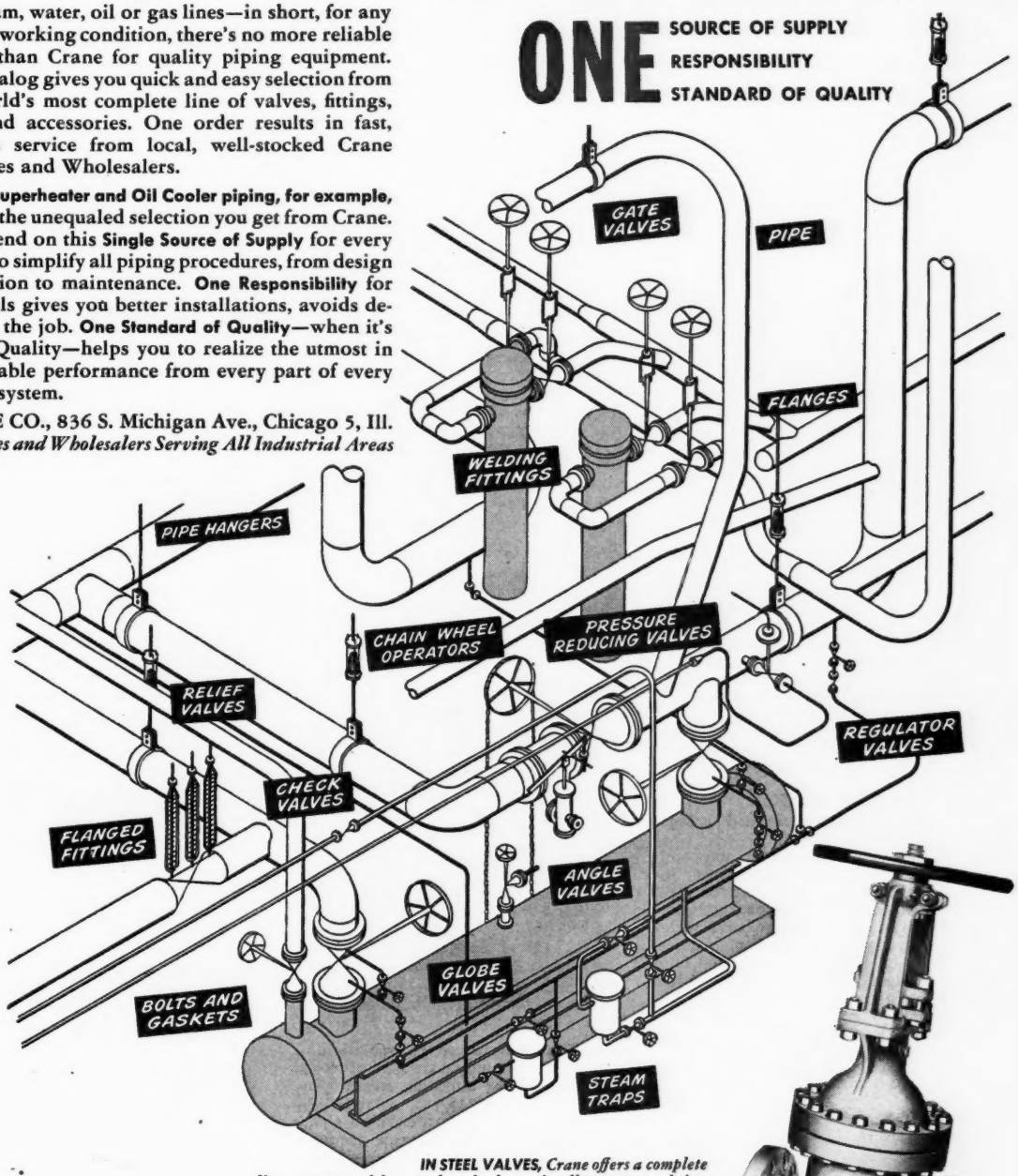
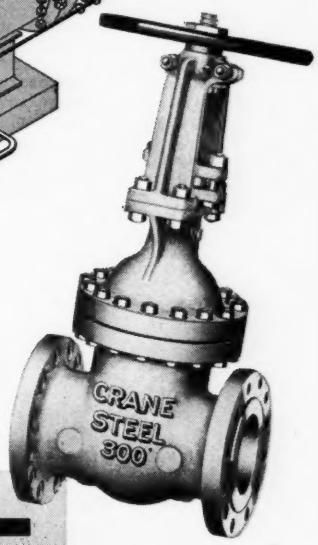




IN STEEL VALVES, *Crane offers a complete line . . . gates, globes, angles, checks . . . in all patterns and sizes . . . in pressure classes from 150 to 1500 pounds. Shown here, Crane No. 33X 300-pound Cast Steel Wedge Gate, trimmed to handle temperatures up to 900 deg. F. Flanged, screwed or welding ends. See your Crane Catalog, p. 304.*

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

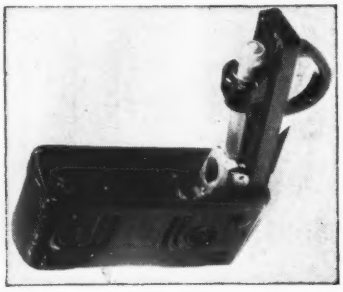
FOR EVERY PIPING SYSTEM

cool air from the floor level to the working level, this unit is also said to be a perfect portable heating unit for construction jobs, where it may be moved to position and hooked up in a comparatively short period of time. Thermobloc Div., Prat-Daniel Corp.

4—DISTRIBUTION CUTOUT

For installation where high capacities are required

Recently announced Type HC cutout has an interrupting capacity of 8000 amp at 2500 v, or 5000 amp at 5 kv. It's rated at 5 kv, 50 amp, and will take any standard universal type fuse up to its capacity. Applicable for use on 2400 v delta, 4160 v Y, 4800 v delta, and 8300 v grounded Y systems. Cutout consists of porcelain box used in current EA



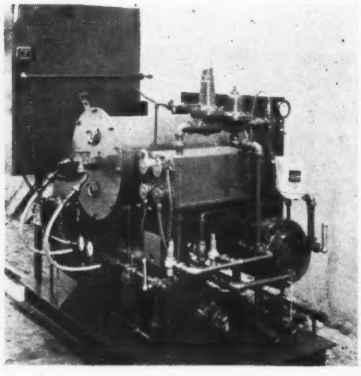
standard interrupting capacity and new high-strength, high capacity door.

Door can be purchased separately for replacement for existing doors of standard EA cutout. High interrupting capacity is obtained by removing old door and installing new one with no change in cutout box or wiring. Both dropout and non-dropout doors are available for installation on existing EA cutouts where short circuit currents have grown beyond ratings of existing cutout. Westinghouse Electric Co.

5—AUTOMATIC BURNER

A completely self-contained packaged combustion system

Available for both automatic and semi-automatic control, this new burner incorporates a complete system of fuel-oil pumping and oil pre-heating equipment, forced draft blower, and wide-range constant differential mechanical atomizing oil burner; all mounted on a compact steel base ready to be bolted to the boiler front. The only field requirement to complete installation is the connection of service lines. This burner is designed to fire boilers at capacities of 100 developed hp and upwards.



Economy is stressed as a major advantage of this burner. Since its installation doesn't require assembly of many related pieces of equipment there's a reduced installation cost. And its space-saving feature and "central station" efficiency offer opportunities for lowered overhead. Peabody Engineering Corp.

6—SLIDE RULE

Tells correct circuit breaker size by flexible, comprehensive means

This slide rule is a simplified means for determining the correct size air circuit breakers for all industrial substation applications.

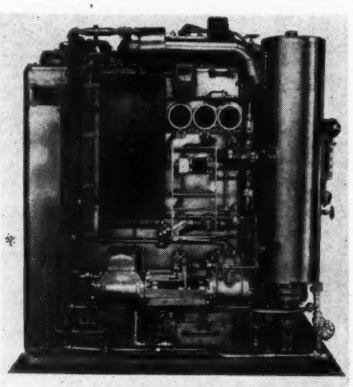
With this rule, anyone can easily calculate the interrupting capacity of the 600-v class air circuit breakers needed for control of power in all industrial plants. Use of the slide rule constitutes a more flexible and comprehensive means of properly applying breakers.

The Unit-Sub rule has been constructed from standard AIEE formulas for determining short circuit currents, and takes into consideration all necessary factors, such as motor load and d-c component. While the slide rule has been specially developed for use in load-center unit substation applications, it can be used to check breakers on any system. It applies to direct connected as well as cascaded breakers. Allis-Chalmers Mfg. Co.

7—STEAM GENERATOR

Forced recirculation type, it's fully automatic

This Elesco steam generator is for train heating, particularly Diesels; fully automatic in operation, it employs



special type of forced recirculation. A motor driven pump at constant speed circulates water through steam generating elements at a rate approximately ten times maximum steam output, greatly reducing scale accumulation. Recirculation pump takes water from a steam separator and discharges it into an inlet header into which several steam generating elements connect, each having a metering orifice at its entrance, insuring proper distribution of water. Each element outlet end discharges into an outlet header. Standard reciprocating feed pump discharges makeup feedwater into outlet header where the water is heated to steam temperature. This header discharges into the steam separator, dry saturated steam being drawn off from the top along with oxygen and other gases liberated, and the water flows by gravity to the recirculation pump.

The steam generator can also be used in other services, where steam must be available on short notice, where space and weight are limiting factors, and where particular operating requirements call for compact, sturdy, automatic equipment. Combustion Enginering—Superheater, Inc.

8—WICK OILER

Variable-feed type, with removable wick retainer

These oilers are recommended for any equipment having solid bearings oiled from the top, where a measured quantity of filtered oil is desirable. Feed of oil is controlled by varying size of wick embodied in tamper-proof base fitting. Greater feed variation can be obtained by using lighter or heavier oil. Will feed oil or liquids as thin as water or as heavy as molasses. Crystal clear, shatter-proof plastic bottle keeps oil supply always visible. All metal parts heavily plated for corrosion resistance, easy cleaning. Large sediment chamber traps dust, dirt, chips and fittings—wick completes filtering. Oilers are said to pay for themselves by savings in time, labor and maintenance through elimination of "trust-to-luck" hand-oiling. One filling of the reservoir lasts a long time. Oilers are available in four types: with or without sight-fitting and with or without feed shut-off; each type comes in 1, 2, 4 and 8 oz. capacities.

Five wicks, of graduated delivery capacity are furnished with each oiler. Additional wicks available at low cost. Trico Fuse Manufacturing Co.

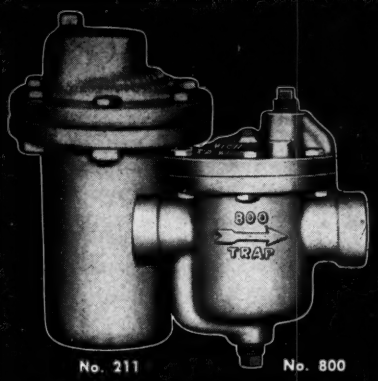
9—TRANSFORMERS

Three-phase distribution type for small loads

This line of CSP three-phase distribution transformers for small industrial or commercial loads. Incorporates all the protective features of the manufacturer's CSP ("completely self protected") single-phase distribution transformers, including built-in De-ion lightning arresters, three mechanically interlocked, heavy-duty circuit breakers on the secondary side as safeguards against overloads and short circuits, and primary protective links for system protection. The three-phase line of transformers has been made possi-

ble by the development of a new type BR secondary breaker claimed capable of successfully interrupting 10,000 amp at usual secondary voltages.

The new transformers are available in sizes of 9, 15, 30, 45 and 75 kva for primary voltages of 2400 to 14,400 inclusive and with secondary voltages



No. 211 No. 800

Above left — Armstrong bottom inlet—top outlet series trap.

Above right — Armstrong No. 800 side inlet—side outlet trap.

PROOF THAT ARMSTRONG TRAPS PAY DIVIDENDS:

$26,119.62 FUEL SAVINGS after installing new heating system and individually trapping all mains, risers, coils and unit heaters with Armstrongs. —*L. G. Balfour Co., Attleboro, Mass.*

•

SAVE 3723 GALLONS OF FUEL OIL annually after installing Armstrong traps on kettles and other equipment. —*Mary Lincoln Candies, Inc., Buffalo, N. Y.*

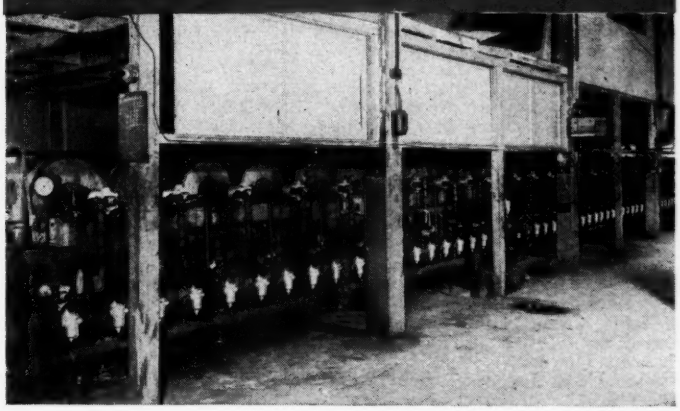
•

30% COAL SAVING at Norton Greenhouses, St. Paul, Minn., resulted after heating coils were individually drained by Armstrong "blast" traps with thermic air vents.

•

15% FUEL SAVING due to Armstrong traps at Sun-Ray Cleaners, Chicago, Ill.

FUEL BILLS TAKE A NOSE DIVE



When You Unit Trap with Armstrongs

Any plant operator or engineer may ask, "Why should I expect to save fuel if I invest in Armstrong Unit Trapping?" The answer is simple:

1. *Armstrong traps can't leak steam*—the hardened chrome steel valve and seat are ground and lapped to a precision, steam-tight fit; they are water sealed at all times. When steam enters the trap, the bucket floats and closes the valve. Full steam pressure against the valve holds it closed—*tightly!*

2. *Non-productive radiation losses minimized*—with Armstrong traps on the job, the steam gives up more heat through the machine, less through the supply and return lines. Air and condensate is discharged as rapidly as it accumulates; heat transfer efficiency in the machine is greater; flow of steam in is more rapid; condensate is discharged at steam temperature — no "cooling legs" needed.

3. *Faster Production*—because Armstrong traps keep equipment HOT, drying, evaporating, cooking, heating and other processes are faster. It takes less steam when it takes less time to complete a heating cycle.

But, the "reasons why" make dull reading compared to the PROOF—see the column at the left. For recommendations and prices on traps for each piece of equipment in your plant send for the 36-page ARMSTRONG STEAM TRAP BOOK.

ARMSTRONG MACHINE WORKS

810 Maple Street • Three Rivers, Michigan

ARMSTRONG *Inverted Bucket* STEAM TRAPS

Sold Under "Satisfaction-or-Your-Money-Back" Guarantee.

of 208Y/120, 240 delta, 240 by 480 delta for the primary classification in accordance with present standards. These transformers have been designed to incorporate the electrical and mechanical features suggested by the EEI-NEMA fourth report on standardization of distribution transformers. Transformers are equipped for pole mounting or mounting on platforms or mats as required. Westinghouse Electric Corp.

10—SOLDERLESS CONNECTORS

With serrated, silver contact surfaces, interlocking sides

This new line of solderless electric connectors with silver on all current carrying surfaces will accommodate a wide range of conductor sizes. Use of silver on contact surfaces is claimed to promote low contact loss, long life and low maintenance, and to prevent oxidation problems. Serrated surfaces give high pull-out strength, positive pressure on cable, resistance to vibration and assure a high conductivity point, say manufacturers.

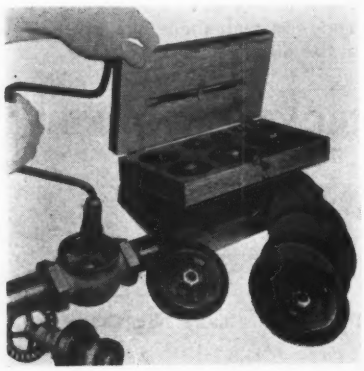
Hardware is high-strength, non-corrodible bronze alloy for tight connections; interlocking sides hold strands of cable within conductor enclosure. Connectors can be installed without removing nuts from clamps, eliminating the trouble of lost nuts and washers. Won't twist or distort or season crack. Available types include straight, tee, block terminal, angle, parallel and ground in both Class A-1 and A-2. Also available are expansion bands, busbar clamps and live line disconnecting clamps. General Electric Co.

11—RESEATING TOOL

For grinding regular types of valves, other equipment

This unique new device is simply designed, employing aluminum-oxide cloth-backed discs mounted on both faces of a flat steel main body and is operated with an ordinary brace or hand drill equipped with a screw-driver bit. While especially designed for regular types of globe, angle, check and gate valves, Pivot seat grinders will work equally well on closet flush valves of both the diaphragm and piston type. The Pivot reseater is self-aligning and no slivers or metal chips result from the grinding operation.

Pivot tools are packed in two sets in hardwood kits. Set No. 60 is for valves ½- to 2-in. inclusive and faucets; set No. 80 is for valves ½- to 3-in. inclusive and faucets. Grace Products Co.



12—EXPANSION CONDUIT

A metallic electrical conduit for wide industrial use

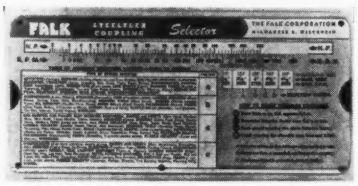
Here's a flexible shielding metallic electrical conduit that features a Neoprene coating, applied through a specially developed process to give natural bond of rubber to metal. This is said to eliminate completely any danger of wiring damage by action of oil or grease. Conduit and couplings are liquid-proof, air-tight and chemical resisting. Depending on conditions of service, this conduit has an operating efficiency life of from 10 to 15 years, according to the manufacturer.

The applications of this conduit include machine tool wiring, chemical plant wiring, paper mill wiring, underground conduits for public utilities companies and wherever standard electrical current has proved short-lived and impractical. Techniflex Corp.

13—COUPLING SELECTOR

Makes it easy to select proper size of flexible coupling

The Steelflex coupling selector, which works like a slide rule, was designed for use by anyone instrumental in the selection and purchasing of flexible couplings. It covers selection of couplings in manufacturer's sizes 3 F to



18 F. This selector is based on a "three-dimensional" method of selecting a coupling: by horsepower, by application and by rpm at which coupling will travel. The selector correlates these three factors which are said to be a more accurate basis for selection than by bore size alone. A Steelflex coupling selector is available without charge to qualified persons. The Falk Corp.

14—DIFFERENTIAL RELAY

Fir switchgears; a high speed device, simple to apply

This new relay is described as a high-speed device. Its designers say most applications of older types, which involved several sources of power, required the use of slow-speed relays in order to avoid false operation on external faults. The new relay is very sensitive to internal (bus) faults, but definitely insensitive to external (feeder) faults. As a result, any usual number of circuits can be accommodated and additional circuits can be added easily. This relay is made up of simple, high-speed, plunger-type units, readily adjustable. General Electric Co.

15—PUMP MOTOR

Deep well vertical type has interchangeable base

This recently announced motor called the Verticlosed Streamway, was designed for application to practically all types of turbine pumps. The Lubriflush lubrication system permits thorough flushing out of all devitalized grease. Gravity-fed oil flow insures the correct oil supply for oil-lubricated models.

Standard models include a reverse protection clutch; special non-reversing locking device can be provided. Other features include asbestos protection of winding, normalized castings to prevent inaccuracies of undue stresses upon bearings, and solid cast aluminum rotor. U. S. Electrical Motors, Inc.

16—POWDER EXTINGUISHER

For use against flammable liquid and electrical fires

This extinguisher is designed for use against fires in industrial plants, oil refineries and pipelines. Made in 20- and 30-lb capacities, it contains a dry chemical powder mixture. It's lightweight and built for one-hand operation with trigger finger control. When lock pin in handle is removed and trigger is pulled, the powder chamber is immediately pressurized by CO_2 released from a small side-mounted cylinder. Simultaneously the powder release valve at top of main powder chamber opens, discharging fine powder through hose and nozzle in a stream that carries 20 ft. Extinguisher can be put into action again without delay. Walter Kidde & Co.

17—FASTENER DEVELOPMENT

For roller chains; increases safety of workers

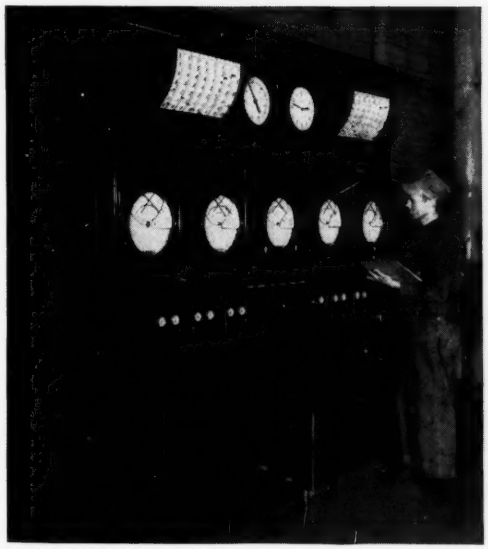
A step ahead in safety, as well as considerable reduction in shutdowns caused by roller chain shear, is claimed possible by a new fastener development. This improvement for roller chains is the result of a new method of fastening roller chain.

The severe abuse under which chains must operate often causes fasteners to be bent, sheared off, or dislodged entirely, resulting in a shutdown for repairs.

This new fastener is a unique type of retaining ring. Provided with three, internal, equally spaced teeth, it is sprung radially into a groove on the pin. The mathematically-predetermined, equal spacing of these teeth, and spring action of the connecting links, assure a tight groove tension at all times. When struck by a direct blow, it merely turns in its groove, hugging it tightly.

If disassembly should be necessary, the recesses between teeth make the ring sufficiently resilient to permit the necessary spread without giving the ring a permanent set. Disassembly is easy, fast, and can be accomplished quickly with an ordinary screw driver. Atlas Chain and Manufacturing Co.

Loafing Btu's produce no power



Bailey Control on two 65,000 lb. per hour boilers at White Motor Co., Cleveland, Ohio. Day to day evaporation runs consistently above the guarantee.

You find loafers everywhere. Even in a collection of Btu's. You have to *make* them work if you expect to get low cost power. And that is exactly what the Bailey co-ordinated boiler control system is designed to do.

It reduces fuel consumption per pound of steam generated. Combustion, feed water, steam temperature, heater levels, pump speeds and other factors are co-ordinated. Safety of operation is increased—continuity of service is improved. You convert the maximum number of Btu's into power and get all the efficiency your boiler was designed to deliver.

One thing to remember, however, is the fact that this Bailey system is not delivered in a standard package. Each one is designed and engineered to the specific job on which it is to be used. That's *why* it functions so efficiently.

If you are looking for low cost power, it will pay you to call our nearest office.

BAILEY METER COMPANY
1040 IVANHOE ROAD • CLEVELAND 10, OHIO
BAILEY METER COMPANY LIMITED, MONTREAL, CANADA

BAILEY METERS

Controls for Steam Plants

COMBUSTION • FEED WATER • TEMPERATURE
PRESSURE • LIQUID LEVEL • FEED PUMPS

A-104

Branches in: Boston, New York, Schenectady, Philadelphia, Buffalo, Pittsburgh, Cleveland, Detroit, Cincinnati, Atlanta, Chicago, Milwaukee, St. Louis, New Orleans, St. Paul, Kansas City, Houston, Denver, Los Angeles, Seattle, San Francisco • Halifax, Toronto, Winnipeg, Vancouver

18—CONTROL CENTER

A dust-tight design to protect working parts

This control combines standard, general purpose control center units with heavily gasketed vertical sections.

The motor control units are mounted entirely within the dust-tight sections. They are claimed to be absolutely standard units such as those used in control centers for general purpose applications. Complete interchangeability simplifies maintenance and contributes to flexibility. The dust-tight design retains all desirable features of established general purpose design—adaptability to exact application, flexibility for meeting changed motor control requirements, safe dead-front operation, economy of installation, ease of maintenance, and neat, appearance. Units are available with circuit breakers through 600 amp, starters through NEMA Size 5, lighting transformers and panelboards, and other miscellaneous devices as covered by NEMA standards. Master load and control terminal blocks (shown in illustration) are optional.

Control centers are available in NEMA enclosure Types I (general purpose) and III (weather-resistant) as well as V (dust-tight). The Square D Co.

19—DEMAND REGISTERS

For use by electric utilities in plants having smaller loads

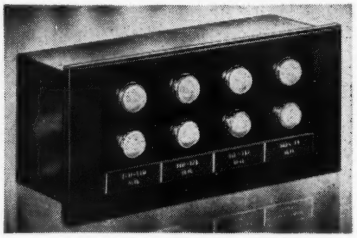
A new line of demand registers for use by electric utilities in industrial plants and commercial establishments having comparatively small loads is announced. Of simplified construction, with fewer parts than previous designs, the new registers are available in two models: the indicating type, M-30; and the cumulative type, M-31. The latter has, in addition to an indicating dial, a set of four dials for accumulating the demand in kilowatt hours from one reading period to another. Both types use a Geneva mechanism for the interval resetting operation. This enables timing motor to reset the pointer pusher by direct-drive gearing without shock, eliminating need for spring and latch mechanisms. Both registers can be used to convert manufacturer's watthour meters into watthour demand meters. General Electric Co.

20—PANALARMS

Multiple signal and alarm systems for industry and power plants

Panalarms, a new conception in industrial signal systems, are multiple signal and alarm systems designed for broad range of use in process work, power plants and all applications where sound and visual alarms are required to indicate failure or changes from normal. They are designed to make possible safety shut-downs, sequencing or interlocking of plant operations.

To insure safety and reliability, the



lamps glow dimly during normal operation.

Where there is an abnormal condition, two signal lights go on and a warning is given by a horn, or other sound device. When the failure is acknowledged by the operator, the horn is turned off, and the white light goes off. The horn is immediately back in service for monitoring any further failure. Thus a single horn serves for any number of alarms.

Panalarm cabinets are available in multiple units up to 12 in a single cabinet.

Flexibility in use and design is insured by allowing extra spaces in the cabinet for spare units. The price of all cabinets is practically the same so that extra spaces can be provided for at a minimum cost. Costs per unit are $30 to $40, varying with type and quantity.

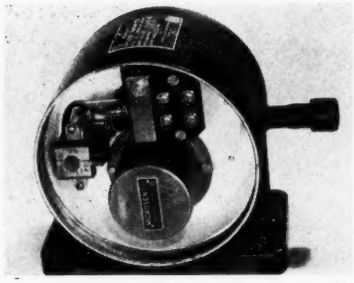
Bulletin 300 Series explains the alarms in detail. Panalarm Products, Inc.

21—PRESSURE TRANSMITTER

Electronic; for economical transmission of pressure indications

Successful and economical transmission of pressure indications is provided by means of a new Microsen pressure transmitter. Pressure motion is picked up from the tip of a Bourdon tube and by means of the Microsen electro mechanical relay this motion is converted into a stable and accurate dc signal which can be indicated or recorded with milliampere or millivolt instruments.

Possible to use uniformly graduated scales. Low cost of operation is also achieved; power consumption is only 2 watts. Maintenance is simplified by case construction which permits servicing either the pressure system or the electrical system independently of each other.

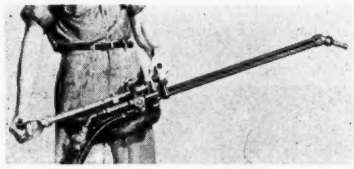


Standard pressure ranges up to 50,000 lb are available. Bourdon tubes are made of alloy steel, bronze, stainless steel, and other materials to meet specific service requirements. Operating voltage is 115 v at 50-60 cycles. Manning, Maxwell and Moore, Inc.

22—STEAM GUN

For volume cleaning operations in industrial plants

The outstanding feature of this new gun, Model 431, the manufacturers report, is its ease of handling. The gun, with an over-all length of 5 ft, is ruggedly constructed and balanced so it may be used over extended periods without tiring the operator. It has two spade-type, insulated handles placed so that each of the operator's hands support the same weight during a high



pressure steam-cleaning operation. A special safety feature is a reinforced rubber apron backing up the steam valve and other hot fittings to protect the operator from burning. According to the manufacturers, the Solution-Lifting Steam Gun, Model 481, develops sufficient vacuum to discharge cleaning solutions to a height of over 12 ft to permit rapid thorough cleaning of large-equipment surfaces. Oakite Products, Inc.

23—ZINC RODS

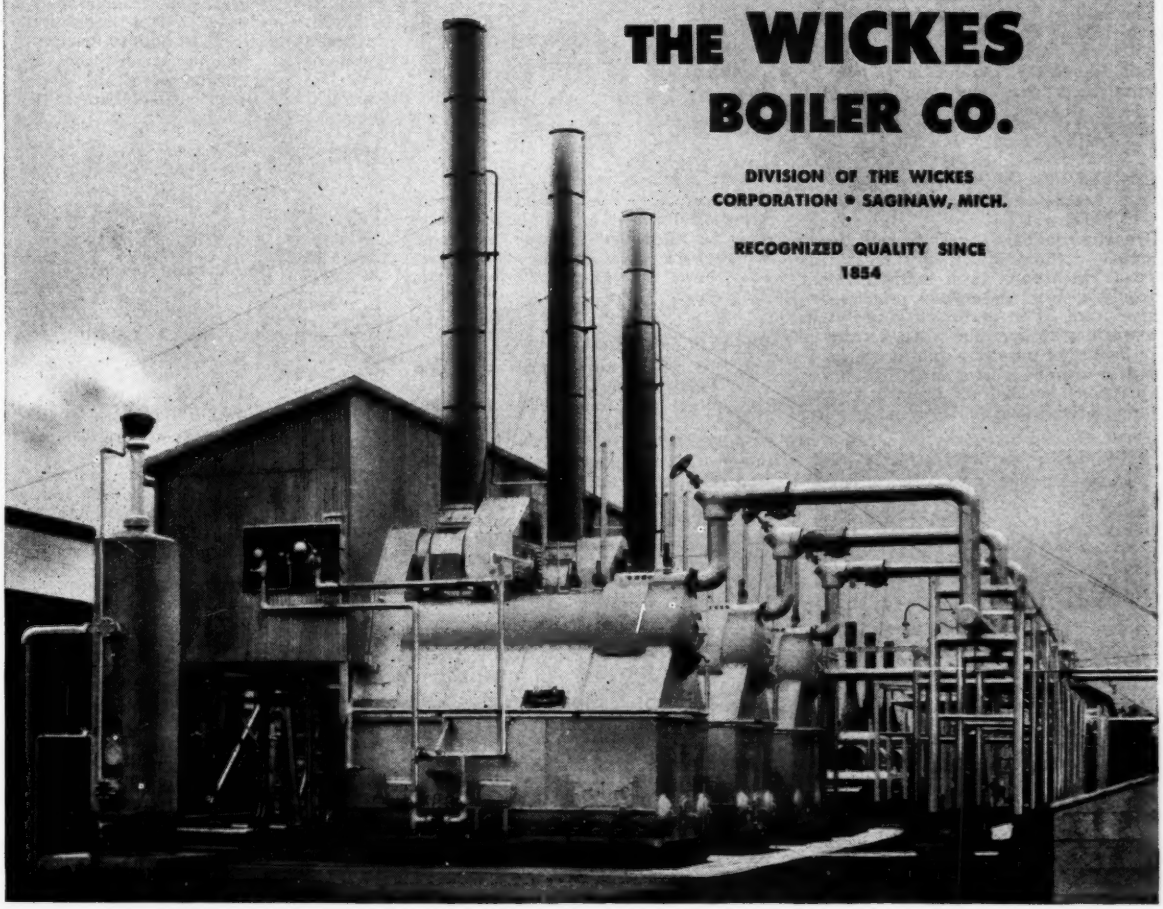
To inhibit corrosion in all types of industrial equipment

Cor-Ins are zinc rods designed to extend corrosion resistant life of water lines, tanks and heat exchangers where corrosive conditions do not seem severe. They are also said to be applicable where corrosion may be aggravated by hot or salt water, catalysts or electrolytic action. The zinc rod used in Cor-Ins has higher electro-chemical potential than metals to be protected from corrosion. Thus, oxygen or other corrosive agents consume the zinc in preference to the electro-chemically less active metals of which hydraulic equipment is made. Cor-Ins are tested for ideal reactivity ratio to insure their becoming more active when corrosive conditions are severe.

Cor-Ins are fitted with standard pipe-plug ends which screw easily into heat exchangers, piping and hydraulic equipment. Rods come in ⅜, ½, ⅝, ¾ and 1-in. diameters with lengths up to 12 in. Rotometals, Inc.

PETROLEUM PROCESSING SPEEDED WITH WICKES TYPE-A STEAM GENERATORS

Profitable processing of crude petroleum into fine oils and fuels requires the most efficient equipment available. These three Wickes Type-A water tube steam generators are operating in an oil field near Delhi, Louisiana. Wickes Package Type-A Steam Generators are compactly designed and efficiently engineered for immediate installation with least possible erection problems. Units are designed for pressures up to 850 psi, producing up to 200,000 lbs. steam per hour. Write for descriptive catalog.



THE WICKES BOILER CO.

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICH.

RECOGNIZED QUALITY SINCE 1854

Sales Offices: Atlanta • Boston • Charlotte • Chicago • Cincinnati • Denver • Detroit • Houston • Indianapolis • Kansas City • Los Angeles Milwaukee • New York City • Pittsburgh • San Francisco • San Jose • Seattle • St. Louis • Tulsa • Saginaw • Mexico City • Buenos Aires.

24—INDICATORS

Crayons, pellets and liquid for indicating temperatures

The development of additional temperature ratings of Tempilstiks (crayons), Tempilaq (liquid) and Tempil Pellets to provide industry with a fuller range of these temperature-indicating products is announced by their manufacturer. All three products are now, for the first time, available in 12½-deg intervals from 113 to 450 F. From 400 to 1600 F Tempilstiks and Tempilaq are available in 50-deg increments while Tempil Pellets can be had up to 1700 F. Tempil Corp.

25—SAFETY SIGNAL

Flashes a red light in presence of combustible gas

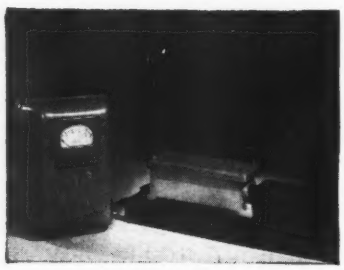
Designed as a safety guard for workers in utility vaults, manholes, storage tanks and other confined places, the new MSA Explosilite flashes a brilliant red signal when a dangerous concentration of combustible gas is present in the surrounding air. It carries the approval of the U. S. Bureau of Mines for use in atmospheres contaminated with methane.

Completely portable and self-contained, the signal may be present for specific concentrations of natural gas or petroleum vapors. It works automatically, continuously sampling the air, and requires no training on part of user. Current for this signal is supplied by an Edison nickel-iron battery which will operate the instrument 18 to 20 hr. Tamper-proof, the Explosilite can be opened for adjustment only by authorized personnel equipped with special magnet. Mine Safety Appliances Co.

26—STRAIN GAGE

Magnetic; for measuring small distortions

This magnetic strain gage provides a simple method of directly measuring small distortions in a static member resulting from a tensive or compressive load. It is particularly useful as a warning to operator when a crane is in danger of upsetting due to overloading, or on other metal structures where variations in load may approach safe limits of the supporting member. The



unit consists of the strain gage enclosed in a water-tight case (3-½ by 8-¼ by 3-¼ in.) and pilot bar sensitive to a force as small as 20 lb, rigidly mounted on the supporting member, and a controller with indicating dial located wherever desired near the operator. Operation is from a single phase, 110 v, 60 cycle supply. Voltage and frequency variations should not exceed plus or minus 3 per cent. Power required is 35 va. Westinghouse Electric Corp.

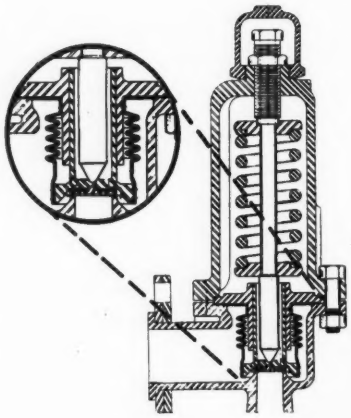
27—SAFETY VALVE

With built-in bellows; isolates lading fluid

A great cause of failure in safety relief valves, the maker claims, is due to the attack of acids on the valve spring. The FarriSeal Bellows prevents gases or liquids from entering the spring chamber, without retarding operations of the valve.

The FarriSeal Bellows is, as its name implies, an enveloping bellows built into the valve itself. It is made in Type 316 stainless steel as a standard, and is also available in rubber and Neoprene for chemical and corrosive-resistant types valves.

The bellows are built to allow safety valve its full stroke plus over travel, and at the same time never reach stress limits of the bellows themselves. Valves with the FarriSeal Bellows in



them have been tried in field service and are said to have proven satisfactory. The FarriSeal Bellows have been used where back pressures on the bellows have been as high as 150 lb. Farris Engineering Corp.

28—ELECTRIC DRILL

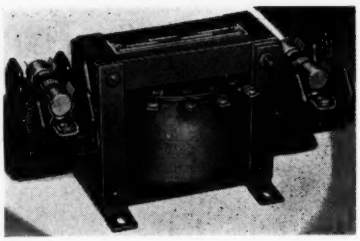
Full ¼ in. capacity; has palm grip handle, trigger switch

Designated as Model 1950 this new streamlined electric drill incorporates a fan-cooled, universal 110-115v ac-dc motor. Other voltages can be supplied. Housing, handle and gear case are die cast aluminum. Built in Cutler-Hammer trigger switch gives convenient, instant control. Drill is supplied with rubber covered cord and attachment plug. Specifications include: no-load speed, 1600 rpm; full load speed 900 rpm; capacity in steel ¼ in.; capacity in hardwood ⅜ in.; and weight of drill 3½ lb. Portable Electric Tools, Inc.

29—CONTROL TRANSFORMERS

Are compact in design and easily mounted

These Class 9070 Type A control circuit transformers were designed specifically for use with industrial control equipment, which is characterized by high, momentary inrush currents to the a.c. operating magnet coils. The manufacturer claims the low impedance values of transformer windings result in unusually good transformer regulation during peak current periods. To provide secondary circuit protec-



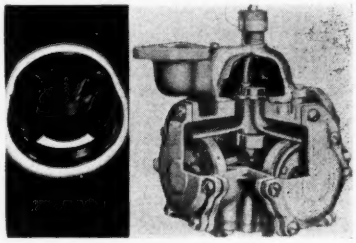
tion, either one or two fuse and bracket assembly units can be easily mounted directly on the transformer.

These control circuit transformers are compact and easy to mount, and built for front-wired control panel use. Accessible, screw type terminals permit panel wires to run directly to transformer, avoiding splices usually required with flexible leads. Available in 50, 100, 150, 300 va at either 50/60 or 25 cycles, and 500 va at 50/60 cycles, with primary voltages of 220-440 (dual voltage), 550, 440, 380, and 220, and secondary voltages of 110 or 24 v. Square D Co.

30—ROTARY VALVE

For liquid meters handling all types of fluids

This self-lubricating Morganite valve was originally produced and tested for use in gasoline meters where high maintenance costs and inaccuracy in measuring were constant trouble spots. First tests indicated a 90% reduction in operating troubles due to friction, gumming and sticking; when placed in actual service, results were said to be even better than anticipated. Morganite, Inc.



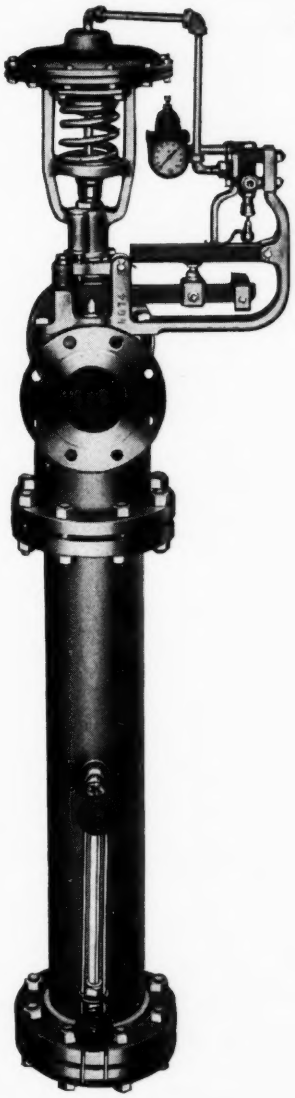
31—SOLDERING IRON

Self-heating; needs no electricity or external heat

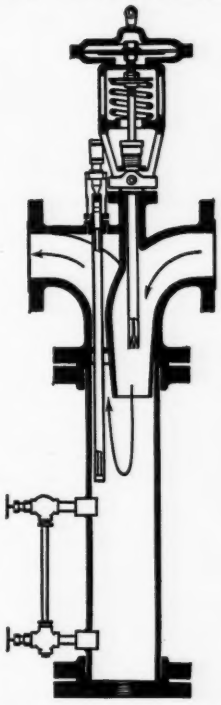
Requiring neither electric current nor external heat, a new soldering iron, known as the Quik-Shot, utilizes a chemical cartridge said to heat the iron to working temperature in 5 seconds and maintains it at an average soldering temperature of 800° F. for fully 7 minutes. The cartridge, about the size of a small flashlight battery, is ignited by impact of a spring rod which is pulled out and released at the handle. Six interchangeable tip sizes are available, ranging from ⅜ to 1⅛ in.

Retail price is $5.95, including a package of 4 cartridges. Kemode Manufacturing Co., Inc.

Self-Contained DESUPERHEATER



Cooling water completely atomized at all rates of flow . . . final steam temperature held closely . . .



Easily installed, the COPES Desuperheater holds the final steam temperature within plus-or-minus 5 degrees F., regardless of changes in initial temperature or rate of flow. Self-contained, it has no outside valve controlling flow. Complete atomization of the cooling water is assured by controlling its flow at the spray nozzle, across which pressure drop is held constant. Intimate contact of water and steam is at point of greatest turbulence in mixing chamber. Write for descriptive Bulletin 405-A.

NORTHERN EQUIPMENT COMPANY
392 GROVE DRIVE, ERIE, PA.
BRANCH PLANTS: Canada, England, France and Austria
Representatives Everywhere

ENGINEERED BY THE MAKERS OF COPES
FLOWMATIC

COPES furnishes pressure-reducing and desuperheating stations designed and built for the individual installation. COPES also builds-to-measure boiler superheat controls responsive to both steam flow and temperature.

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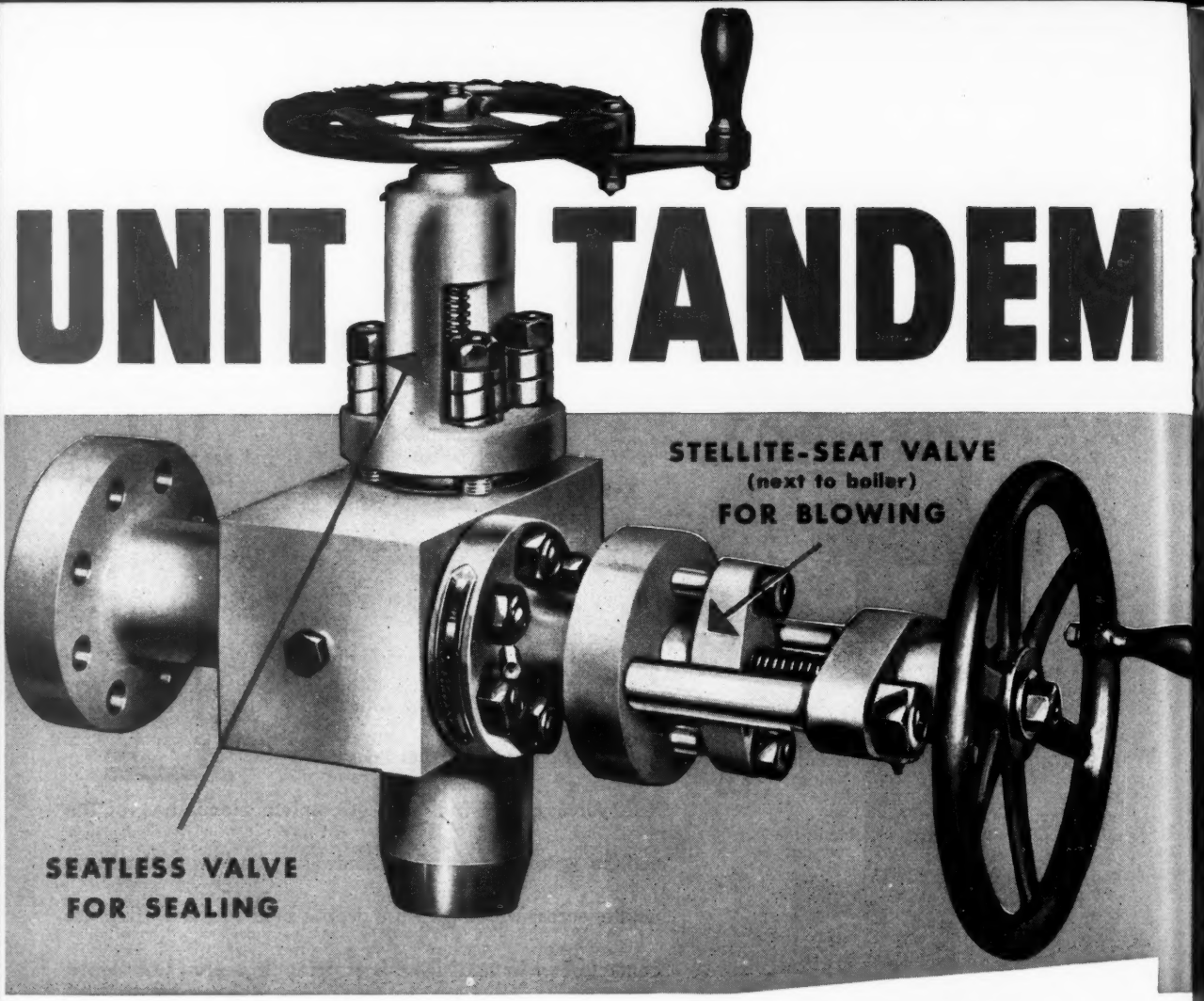
Boiler Feed Water Control . . . Excess or Constant Pressure Control, Steam or Water . . . Liquid Level Control . . . Balanced Valves . . . Desuperheaters . . . Boiler Steam Temperature Control . . . Hi-Low Water Alarms.

UNIT TANDEM



YARWAY'S Answer to High Pressure Blow-Down Requirements

As pressures increase, so does the demand for dependable blow-off valves to meet these needs.

The Unit Tandem is Yarway's answer . . . proved by hundreds of successful high pressure installations in leading utilities and industrial plants.

This blow-off valve, combines the worth-while improvements and advances both in metallurgy and mechanical design.

Unit Tandems are built for pressures to 2500 psi.

Inside (next to boiler) blowing valve is the Yarway Stellite-Seat valve.

Outside sealing valve is the famous Yarway Seatless design which has no seat to score, wear and leak. This valve is always opened first and closed last, maintaining a tight seal at all times.

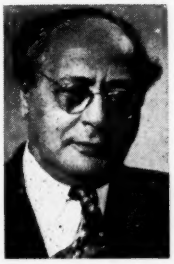
Write for Yarway Bulletin B-432 for complete description of this Unit Tandem. For lower pressures ask for Bulletin B-424.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Penna.

YARWAY BLOW-OFF VALVES

The Men Behind Your Products

By DR. OTTO EISENSCHIML



THE OTHER DAY a salesman stepped into my office and presented his line of goods. He was a live young fellow, and the firm he represented has a national reputation. The products he displayed meant a radical departure from previous practices and, although I was attracted by them, my interest was tempered by caution.

"Who heads your research department?" I asked him.

He gave me a blank stare. "I have not the slightest idea," he confessed. "Why do you ask?"

"I am not through yet," I continued. "Who is your chief chemist? Who is your chief engineer?"

He shook his head in bewilderment. "Why do you want to know?" he repeated.

"Because," I explained, "my faith in these new products will be governed by the caliber of the men behind them."

The salesman let his remark sink in for a moment.

"Do you know," he finally said, "I have never thought of that. I could give you the names of our president, vice-president, and sales manager, and even that of our switchboard operator; but, I am ashamed to say, I myself have never inquired who develops the products I am selling. And what is more, as a prospective customer you have a perfect right to know their identity and their background."

A week later the salesman came back and gave me the information I had asked for. I happened to know the research director personally, and the chemist by reputation. That is all I needed to know, and the salesman walked out with a good-sized order.

Sometimes I wonder if our industries, which are generally so wide awake and spend a lot of money on research, fully appreciate the asset value of their technical staffs and its adaptability for aggressive sales promotion.

I have before me a recent copy of a well-known local newspaper. One full page of it is devoted to the pictures of its Washington correspondents. Some of the names have been familiar to me for a long time, others have not; but from now on they all will be. The next time I read a Washington report carrying a byline, the name of the author will bring back to me his picture, and I shall read his column with greater interest. Should no name be mentioned, I shall probably be wondering which one of the staff members had written it.

Is it not strange that this simple and eminently fair mode of sales promotion has not occurred to the manufacturing fraternity? I have discussed this matter with the heads of various corporations, and in theory they all agree that the newspaper has developed a sane and successful approach. It is based on the fact that human beings are always interesting, and that interest in a product can be enhanced by connecting it with a living person. This holds good whether it is a newspaper article, a pharmaceutical preparation, or a new kind of valve. Yet, no manufacturer has adopted such product identification, so far as I know. Could it be that no one wants to be the first to try something new?

Oh, yes, I have heard some objections, such as "my chemists and engineers are not well enough known to impress the masses." Sure, and they never will be unless you let the public know who your men are and what they have accomplished. Try introducing them to the public along the lines adopted by the paper mentioned above, and they will get known quickly enough.

"If I do publicize my best men," another objection runs, "my competitors will try to grab them away from me."

Of course they will. They also have probably tried to grab away the newspaper's correspondents, but somehow I have seen the same bylines for many, many years. People do not easily leave a satisfactory position, and the present employer always has the inside track.

I venture to say that those who will take up this idea will find it yielding dividends in more ways than through the order department. For one, it will attract men of quality to a place of employment where they are respected as individuals and do not forever remain anonymous.

There is something else that should not be ignored. High grade technical men are rarely greedy, and money is not all that makes them happy. They are scientists who have that everlasting urge which accompanies creative genius, and they should be treated accordingly. A public show of confidence, a visible proof that management takes pride in them may mean as much to them as dollars and cents, and they will repay it in increased loyalty and diligence. The work of creative men cannot be measured by the time-clock. With them it is not a matter of hours but of inspiration, mood, ambition. Public recognition will not only stimulate them, but will make them give you their every creative effort.

Your laboratory is the place where new ideas are born and nursed to fruition. Without it any business will stagnate and eventually die. A laboratory by itself is nothing but a pile of bricks, stocked with scientific tools. But your technical staff, the men you rarely see in the front office, are the rejuvenating force of your organization. They are not unlike the Hesperides in Greek mythology, who kept the gods young by feeding them golden apples.

Gentlemen, who is your chief chemist? Who is your chief or plant engineer? And who is the director of your research department?

In the September 1948 issue, Dr. Otto Eisenschiml called for engineers to come out of the kitchen, on appropriate occasion, and take their rightful place in the parlor where matters of policy are being discussed. Here he presents a very practical way in which industry can capitalize on the work of its technologists, whose caliber determines the caliber of industrial products without which there would be no policy. The above comments were first published in ***Manufacturers' News,*** then in ***The Frontier.***

Many people know Dr. Eisenschiml as an authority on the life of Lincoln; he is author of such books as "Why Was Lincoln Murdered," "In the Shadow of Lincoln's Death" and others.

These, however, are his avocations. His work is that of the chemist, engineer and industrialist. Born an American citizen in Vienna, Austria, he served as chemist for Carnegie Steel Co., Pittsburgh, Penn. from 1901 to 1904. Then until 1912 he was chief chemist of American Linseed Co., Chicago. From 1912 to the present he has been owner and president of the Scientific Oil Compounding Co. He is co-author of the Eisenschiml-Copthorne method and inventor of other technical processes. He has been chairman of the Chicago Section of American Chemical Society, president of the Chicago Chemists Club, active in various national, state, and local scientific committees and civic organizations.

Port Washington No. 3 Goes on the Line

Unit No. 3, an 80-000-kw, 1290-psi, 900-F, 1800-rpm turbine generator, with reheat, served by one 690,000-lb-per-hr boiler, put in service in October 1948 at Port Washington Station of the Wisconsin Electric Power Co. Increases station capacity to 240,000 kw; three similar units installed over 13-year period . . . Storage type pulverized coal firing, mill drying . . . Magnetic fan couplings . . . Average present heat rate, 10,101 Btu per kw-hr . . . Reheater dump valve . . . Operating experience for 1948, for entire station and Unit No. 3

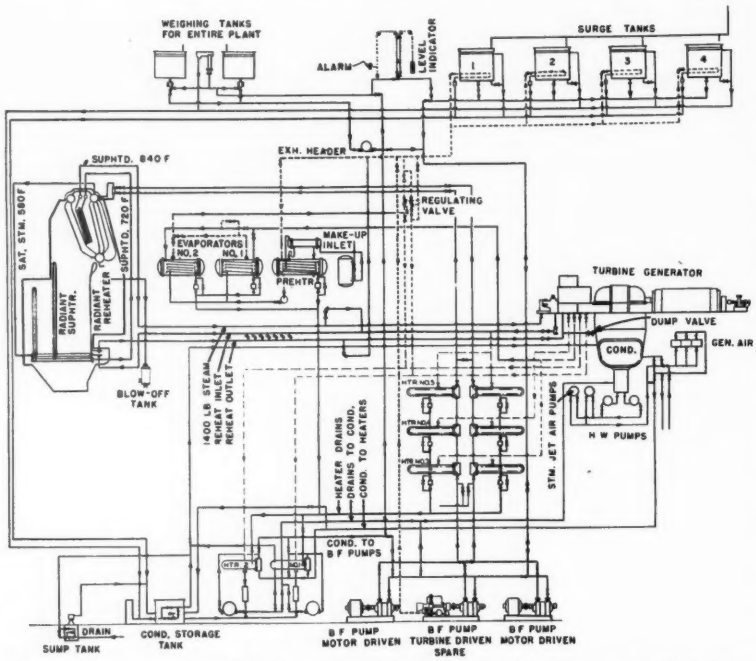


Fig. 1. Flow diagram for Unit No. 3, Port Washington, is almost identical with that for Unit No. 1 in 1935, except for use of reheater-system dump valve

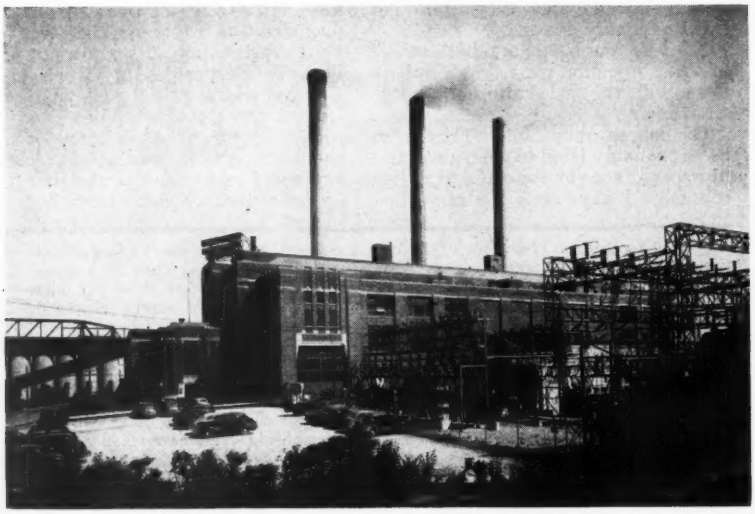


Fig. 2. Exterior view of Port Washington Station of Wisconsin Electric Power Co., on Lake Michigan 28 miles north of Milwaukee, Wisconsin, as it appeared in July 1948. Third unit now finished and operating

AT PORT WASHINGTON STATION of Wisconsin Electric Power Co., on Lake Michigan 28 miles north of Milwaukee, Wisconsin, Unit No. 3 went into operation on October 5, 1948. This installation consists of an 80,000-kw, 1290-psi, 900-F tandem-compound turbine generator with reheat to 900 F, supplied with steam by a single 690,000-lb-per-hr pulverized-coal-fired boiler. This third unit is of fundamentally the same design as Units 1 and 2 in the station.

Thus the Port Washington plant now has a total installed capacity of 240,000-kw in three individual and nearly identical units of 80,000-kw each. Brief comments on the operation of the entire station are given below and List of Equipment for Unit No. 3 on page 68.

The operating results obtained at Port Washington have been of great interest to the entire power field ever since its first unit was installed in 1935 by the Milwaukee Electric Railway and Light Co., now the Wisconsin Electric Power Co.

Development of the Station Since 1935

Features incorporated in the first unit in 1935 represented, at that time, the results of one of the most striking examples of organized development to be found in the utility industry. The design resulted from two decades of pioneering work, principally at the Lakeside Station, with pulverized coal, high pressure, radiant superheaters and water conditioning.

Developments in these fields resulted in a boiler design with an availability equal to that of the turbine and made the one-boiler-per-turbine or unit design practicable for Port Washington.

Low Heat Rate

One of the features of the station was, and still is, the low heat rate for which it was designed and has operated from the first. In April 1936, for Unit No. 1, the heat rate was reported as 10,946 Btu per kwhr; and at present, because of constant refinements in operation year by year, the heat rate for this unit now averages 10,761 Btu per kwhr for 1948 as shown in Fig. 4. Other fea-

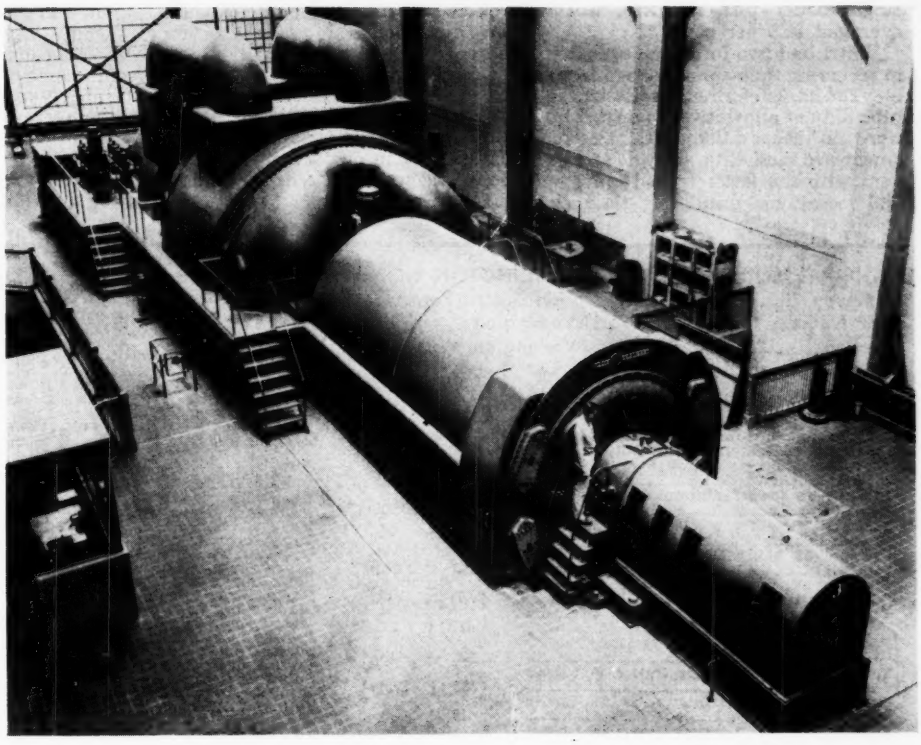


Fig. 3. View of Unit No. 3 turbine generator at Port Washington, from generator end. This is an 1800-rpm unit generating at 22,000 v

tures of Unit No. 1 were: Use of 825-F steam temperature, with reheat to 825 F; use of a storage-type pulverized coal system; furnace of ample proportions designed for very conservative heat release; use of all-electric auxiliaries; generation at 22,000 v; and other factors that were advanced design in their day.

These design features have been followed in developing the station since 1935. According to the unit plan originally adopted, each additional unit could take advantage of previous experience and incorporate the latest developments in power plant design.

Unit No. 2, placed in operation in October, 1943, was fundamentally the same as Unit 1 except for certain changes in details. In Unit No. 2, welded pipe joints and valve bonnets, and welded superheater and reheater joints were used and some changes were made in the furnace-bottom screen. Boiler heating surface in rear pass was increased. Changes in furnace air supply were made. The No. 2 turbine generator was equipped for hydrogen cooling (Unit No. 1 was air-cooled); turbine blading was improved; superheat and reheat temperatures were increased 25 F; Unit 2 was designed for 29.5 in. Hg vacuum (Unit No. 1 was for 29 in. vacuum). Present heat rate of Unit No. 2 is shown in Fig. 4.

The same fundamental design was again employed for Unit No. 3. Full details of the main units and auxiliaries are shown in the List of Equipment. Performance of Unit No. 3 for its first three months of operation is shown in Fig. 4 and in the tables.

There has been widespread interest in the station on account of: its low heat rate; the fact that none of the Port Washington boilers has ever been turbined or acid cleaned; the reports that lancing of tubes is infrequent, and furnace cleaning and soot blowing operations at a minimum; successful use of mill drying of coal in the mills by flue gas, thus simplifying the storage system; use of mutliple burners across the furnace front and many other features of design and operation. As a result, regular reports on operating experiences of the station have been published in the technical press (see bibliography at end of article).

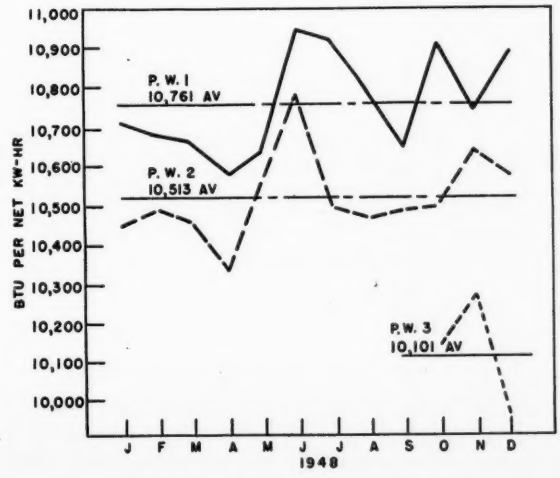


Fig. 4. (Left). Comparative heat rates of three units at Port Washington for 1948

1948 Operating Experiences

Minimum outage time, encouraged by inadequate system reserves, characterized 1948 operation at Port Washington. Units 1 and 2 operated 96 per cent of the year. For the last two years, the availability of these

Table I. Output and economy data, Port Washington

Unit No.	Period (Incl.)	Net Output 10^3 Kw-hr	Load Factor %	Btu per Kw-hr Net
1	1948	559.97	84.3	10,761
	1935*-48	5,782.191	66.5	10,835
2	1948	574.122	86.2	10,513
	1943*-48	2,669.992	77.7	10,581
3	1948*	117.551	78.5	10,101

*Nov. 22, Oct. 27, and Oct. 5 startings, respectively.

single-boiler-per-turbine units averaged 95.9 per cent.

Unit 1 had two forced outages due to recurring tube-joint leakage trouble. Tie-backs of a rear-wall furnace tube did not allow it to travel downward in cooperation with 1½ in. downward mud-drum travel; and its joint with the latter leaked on several occasions until the tie-back trouble was disclosed and corrected. However, Boiler 1 availability for the year was 96.9 per cent.

Boiler 1 is not positively free of the screen-tube corrosion trouble previously described in the literature.[3] During the October outage, a minute leak in one screen tube was found and was repaired by welding. The corrosion rate is low and is limited in total extent.

Unit 2 had two short outages due to erroneous operation of automatic equipment, no longer in use. Much trouble with leakage of steel tubes in high-pressure heaters has prompted plans to change to copper-nickel tubes in this unit.

Recently, 50,000 tons of Western Kentucky coal of 2040 F ash fusion

PRINCIPAL EQUIPMENT PORT WASHINGTON NO. 3

Company.....Wisconsin Electric Power Co.
Plant Name.....Port Washington
Location.....Port Washington, Wisconsin
Capacity.....80,000 kw

STEAM GENERATING EQUIPMENT

Boiler Performance Data as Estimated in Boiler Contract		
Guaranteed Maximum Steam Output, Lb/Hr	690,000	
Estimated Flow to Throttle @ 80,000 Kw Lb/Hr (A. C. Co.)	585,000	
Steam Flow for a Maximum Operating Load Lb/Hr	635,000	(610,000)*
Reheater Flow for a Maximum Operating Load Lb/Hr	590,000	
Pressure at Boiler Drum @ 635,000 Lb/Hr (Psig)	1,325	(1,340)*
Pressure at Superheater Outlet @ 635,000 Lb/Hr (Psig)	1,300	
Temperature at Superheater Outlet @ 635,000 Lb/Hr	877	(875)*
Pressure at Reheater Outlet @ 590,000 Lb/Hr (Psig)	375	(410)*
Temperature at Reheater Outlet @ 590,000 Lb/Hr (Deg F)	835	(885°)*
Pressure at Reheater Inlet @ 590,000 Lb/Hr (Psig)	415	
Temperature at Reheater Inlet @ 590,000 Lb/Hr (Deg F)	598	
Feed Water Temp. @ 635,000 Lb/Hr	428	(428°)*
Air Heater—		
Air Inlet Temp Deg F, @ 635,000 Lb/Hr..	180	
Air Outl. Temp Deg F, @ 635,000 Lb/Hr..	573	
Gas Inlet Temp Deg F, @ 635,000 Lb/Hr..	751	
Gas Outl. Temp Deg F, @ 635,000 Lb/Hr..	356	
Overall Efficiency, %	86.4	
Type of Furnace Bottom	Dry	
Method of Ash Removal	Hydraulic Sluice	
Method of Superheat Control	Superimposed Radiant and Convection Superheater (plus variations of burners nearest side wall superheaters, plus spray tube desuperheater in inlet pipes of reheating superheaters, in emergencies).	

* Actual from Bailey Meter charts 12-10-48 for 80,000 Kw load.

Heating Surfaces—Sq Ft	
Boiler	55,800
Water Walls and Screen	8,040
Superheater—Radiant	1,534
Convection	11,000
Reheater	1,430
Air Heaters—Two—60,500 sq ft each	121,000

Boiler	Combustion Engineering Co. 3 drum bent tube
Superheaters—Primary	Foster-Wheeler Corp. Radiant & Convection
Superheaters—Reheating	Foster-Wheeler Corp. Radiant
Air Heaters	Combustion Engineering Co. Plate Type
Coal Burning Equipment	Pulverized Fuel
Type of Burners	Fan Tail, Vertical
No. of Burners per Boiler	20
Pulverized Coal Mills	Raymond Bros. (C. E. Co.)
Type	Roller
Number per Boiler	Two
Tons per Hour, each (nominal rating)	15
Induced Draft Fans	B. F. Sturtevant Div, Westinghouse
Type	Steel Plate
Capacity (each)	185,000 cfm @ 380 F, 11.5" H_2O, 565 rpm
Control	Magnetic Coupling
Drive	600-hp Sq Cage Motor
Forced Draft Fans	2
Make	B. F. Sturtevant Div, Westinghouse
Type	125 Turbovane
Capacity (each)	140,000 cfm, @ 180 F, 12" H_2O, 1125 rpm
Control	Magnetic Coupling
Drive	400 HP Sq Cage Motor
Combustion Control, pneumatic	Bailey Meter Co.
High-Pressure Piping	Lummus Co.
Operating Pressure and Temperature	1300 psi @ 877 F.
Pipe	12¾" O.D. x 10⅛" I.D.
Velocity at Max. Load, Ft per Min	10,600
Allowable Design Fiber Stress (Code)	10,000 @ 900 F.
Material and Grade	Carbon Moly. ASTM—A206—44T.

Feedwater Heaters					
Heater Designation	No. 1	No. 2	No. 3	No. 4	No. 5
Number of Heater Units	1	1	2	2	2
Make	The Griscom-Russell Co.				
Type—Float Head or Return Bend	Return Bend				
Operating Pressure, Psi Abs.	4.5	18.9	73.6	190	428
Heat Content of Steam-Btu/Lb	1032	1108	1206	1329	1306
Steam Bleed, M. Lb/Hr	26.2	32.7	44.5	38	58.5
Design Water Pressure, Psi	80	80	2000	2000	2000
Water Temp. Inlet @ Full Load, F.	71	153	211	292	362
Water Temp. Outl. @ Full Load, F.	153	220	292	362	436
Passes	4	4	2	2	2
Surface, Sq Ft	2000	2000	1412	1368	1020
Vertical or Horizontal	Horizontal				
Sub-Cooling Surface—Sq Ft	—	—	393	342	—
Drip Discharge to Heater	Pump	Pump	2	3	4
Terminal Difference, F.	5	5	19	15	15

Feed Pumps	Worthington Pump & Machy Corp.
Number	Three—7-stage
Capacity, Lb/Hr, Each	500,000
Suction Pressure, Psi	30
Pressure Rise in Pump, Psi	1,380
Temperature, F.	210
Drive	2-1250 hp Motors, 1-1250 Turbine Motors Constant Speed
Feed Water Storage Tanks	
Number	3
Capacity, gallons in 3 tanks	60,000
Temperature, F	210
Feed Water Control	Manual

TURBINE GENERATING UNIT

Turbine	Allis-Chalmers Mfg. Co.
Rated Capacity, Kw	80,000
Type	Tandem-Compound
Blading	Impulse-Reaction
Number of Stages	1 Impulse, 61 Reaction
Rated Steam Pressure (Throttle), psig	1290
Rated Steam Temp. (Throttle) F	900
(Reheat) F	900
Exhaust Press., "Hg. Abs.	0.5
Stages of Extraction	5
Generator	Allis-Chalmers Mfg. Co.
Kva Rating	94,118
Phase	3
Cycle	60
Voltage	22,000
Rpm	1,800
Power Factor	85%
Generator Cooling	Hydrogen
Condenser	Allis-Chalmers Mfg. Co.
Type	Single Pass, rolled-in tubes
Surface, Sq Ft	53,650
Length of Tubes, (Between tube sheets), Ft	26
Diameter of Tubes (O.D.), In.	⅞
Thickness of Tubes	18 BWG
Tube Material	Arsenical Admiralty
Circulating Pumps	Allis-Chalmers Mfg. Co.
Number	Two
Type	Horizontal 54" x 48"
Rpm	232
Capacity—(One Pump Operating) Gpm	73,000
(Two Pumps Operating) Gpm	111,000
Hotwell Pumps	Allis-Chalmers Mfg. Co.
Number	Two
Type	Horizontal, 2 stage
Capacity, each, Gpm	1,000 @ 198
Steam Jet Pumps	Allis-Chalmers Mfg. Co.
Number	Two
Type	Single element—three stage

(softening) temperature was burned in the three units, without increasing excess air and without furnace dirtiness trouble. In fact, this Mid-Western coal was found superior to the much-deteriorated Eastern coal in many respects. That the boiler-plant apparatus utilizes it acceptably seems significant.

That none of the Port Washington boilers has ever been turbined nor acid cleaned may be of interest to some readers.

A weighed-water test of Turbine 3 during normal operation in December, 1948, proved it close to guarantees. The accompanying list of starting experiences concerns only the turbine, for the boiler was ready several weeks earlier and was started without incident.

Economy Results of 3 Units

Economy results of the three units during 1948 are shown graphically in Fig. 4. Port Washington 3's first month's heat consumption, as plotted, does not include coal burned nor auxiliary energy used before starting the turbine, for they are not properly chargeable to normal monthly data. Including these one-time charges increases the October valve to 10,437, which is better than Port Washington 2's figure for the same month.

Life-time and 1948 economy data for each unit is shown in Table I. Use and availability data are recorded on the same basis in Table III, which shows the recent 96 per cent availability previously mentioned. For 1948, turbine availability is slightly better than boiler availability; but, over the years, boiler availability has been almost two percentage points higher.

Reasons for every outage of all three units during 1948 are recorded in Table II. Both semi-annual scheduled inspections of Unit 1 were during week-ends, taking advantage of bright Fridays, and Unit 2 enjoyed only one full-week semi-annual inspection. Both turbines have operated approximately 25,000 hr since last internal inspection.

Table II. Operating periods and outages, 1948, Port Washington

Unit No.	Operating Period No.	Start	End	Hrs	Outage Hrs.	Reason
1	74	*	4-1	2325.12	71.8	General inspection, blr. and turbine (scheduled).
	75	4-4	4-5	8.17	37.1	Furnace rear-water-wall tube failed at mud-drum joint (forced).
	76	4-6	4-16	233.2	128.1	Generator rotor lead failed (delayed forced outage).
	77	4-21	7-30	2403.9	33.4	P.W. 3 elect. connection. Furnace rear-water-wall tube repair (scheduled).
	78	8-1	8-1	13.77	30.9	Furnace rear-water-wall tube repair (forced).
	79	8-3	8-24	517.33	.48	Transm. line trouble; operating error (forced).
	80	8-24	10-21	1392.76	65.13	General inspection, blr. and turbine (scheduled).
	81	10-24	*	1522.8		
	(1948)	*	12-26	8417.07	366.93	
2	24	*	1-25	696.33	8.9	Leaking condenser tube (delayed forced outage).
	25	1-25	6-2	3107.97	.1	Erroneous automatic operation (forced outage).
	26	6-2	7-2	722.27	201.9	General inspection, blr. and turb. (scheduled outage).
	27	7-11	7-11	6.77	28.53	Leaking boiler tube, due to ash erosion (delayed forced outage).
	28	7-12	7-27	342.14	3.02	Erroneous H.P. heater testing (forced outage).
	29	7-27	7-27	1.6	.5	Erroneous automatic operation (forced outage).
	30	7-27	11-4	2408.34	68.68	General inspection, blr. and turb. (scheduled outage).
	31	11-7	*	1186.97		
	(1948)	*	12-26	8472.37	311.63	
3	1	10-5	10-7	45.95	121.13	Generator fan inlet changes. (Scheduled outage).
	2	10-12	10-28	386.35	68.29	Sticking of turbine inlet valves and power piston (delayed forced outage).
	3	10-31	*	1350.23		
1948	.....	10-5	12-26	1782.53	189.42	*Year starts 12-27-47 and ends 12-26-48.

Port Washington No. 3

Lower turbine leaving losses characterize this newest Port Washington apparatus, operated three months at this writing.

The 0.5-in. average annual exhaust pressure of Port Washington No. 1 and 2 urged the use of almost double normal exhaust blade area. In fact, the double-flow low-pressure section of a 147,000-kw turbine for 1 in. average exhaust pressure was used for this 80,000-kw unit because of its 0.5 in. exhaust pressure.

Also, 36-in. blades with 1140 ft per sec tip speed help improve economy at least 3 per cent, relative to Port Washington No. 1 and 2, because of lower leaving losses.

Second most important differences are 50 F higher superheat and reheat temperatures gaining about 1½ per cent over the previous two units. Boiler pressure is the same: 1390

(Continued on page 130)

Table III. Use and availability for three units; first two 1935-1948; third for 1948; Port Washington

Unit No.	Period		Use (Serv. Hr. / Period Hr.)	Hourly-Output (Av. Hrly. Output / Rated " ")	Annual-Output (Annual Output / " Rated ")	Demand (Demand Hr. / Period Hr.)	Demand-Avail. (Service Hr. / Demand Hr.)	Availability (100-Repair Hr. / Period Hr)
1	1948	Blr.	95.8	81.4	78	98.4	97.5	96.9
		Turb.	95.8	87.9	84.3	98.8	96.9	97.0
		Plt.	95.8	87.9	84.3	100	95.8	95.8
	1935*-48	Blr.	89.7	67.4	60.6	93.1	96.5	94.2
		Turb.	89.7	74.0	66.6	97.1	92.4	92.9
		Plt.	89.7	74.0	66.6	99.2	90.4	90.4
2	1948	Blr.	96.6	83.1	80.3	99.9	96.7	96.6
		Turb.	96.5	89.4	86.2	98.0	98.4	97.9
		Plt.	96.5	89.4	86.2	100	96.5	96.5
	1943*-48	Blr.	92.7	77.3	70.9	95.2	97.4	95.9
		Turb.	93.0	83.4	77.7	97.8	95.1	93.8
		Plt.	93.0	83.4	77.7	100	93	93
3	1948*	Blr.	90.4	76.1	68.8	90.4	100	100
		Turb.	90.4	86.8	78.5	100	90.4	90.4
		Plt.	90.4	86.8	78.5	100	90.4	90.4

*Nov. 22, Oct. 27, and Oct. 5 startings, respectively.

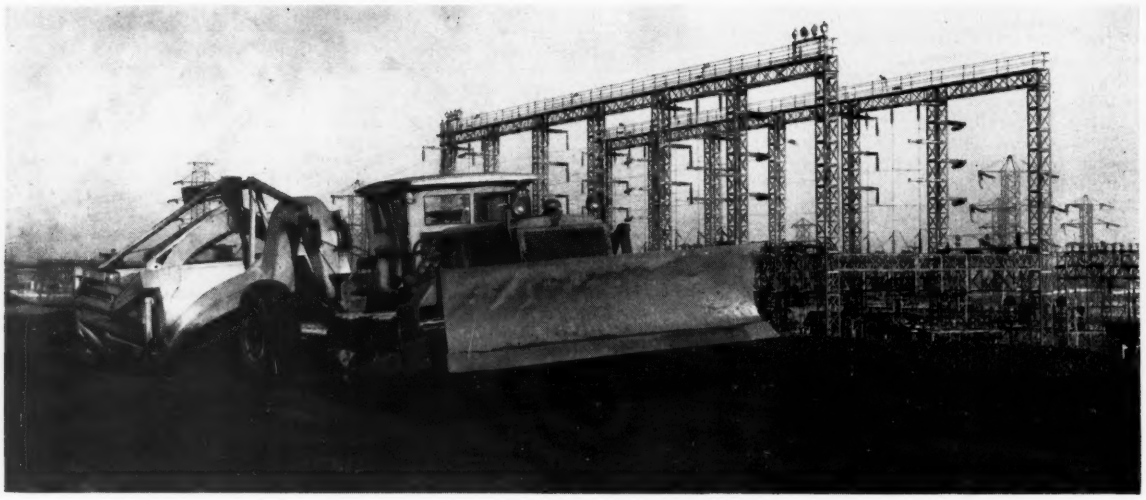


Fig. 1. Crawler tractor loading full trailer-type "carryall" on the stock pile. Drawbar connects tractor and carryall and a pair of cables serves to operate the loading and unloading mechanism of the "carryall"

Handling Coal by Tractor Equipment

By E. A. **RUDULPH** Mechanical Operating Engineer, Union Electric Co. of Missouri

Heavy tractor and scraper equipment, developed in construction field, used generally in utility coal storage . . . Types of equipment available . . . How it is used . . . Recent developments in equipment . . . What should you expect of it? . . . Comparative performance data on caterpillar tractors, used as bulldozers and scrapers, and on self-propelled rubber-tired tractor scraper units . . . Costs given for various conditions . . . Influence of coal characteristics

Fig. 2. Crawler tractor equipped with hydraulic angledozer blade, spreading coal in initial pile preparatory to delivery into storage by scraper equipment

PRACTICE of using heavy earth-moving equipment of the tractor and scraper type, which in the past has received almost universal acceptance in the construction field, for handling coal into and out of storage piles, has been pretty generally adopted by the electric utility companies. The technique, which has been pretty well standardized*, is, in brief, as follows:

1. Unload coal received with the normal unloading equipment.
2. Divert coal to be stored into an initial pile or loading hopper.
3. Pick up coal to be stored from the initial pile with a self-loading scraper, or load the scraper from the hopper.
4. Spread coal over storage pile in thin, horizontal layers and compact it by overtraveling or by rolling with crawler type tractor.
5. Recover coal when needed by reverse process, picking up the coal from the storage pile by the self-loading scraper and discharging it to the plant conveyor system, for delivery to the bunkers through the normal plant process and handling system.

Equipment Available

The crawler or so-called "caterpillar" type tractor, with its high tractive effort, great stability and general all around usefulness, is

*Coal Storage Manual, *Power Plant Engineering*

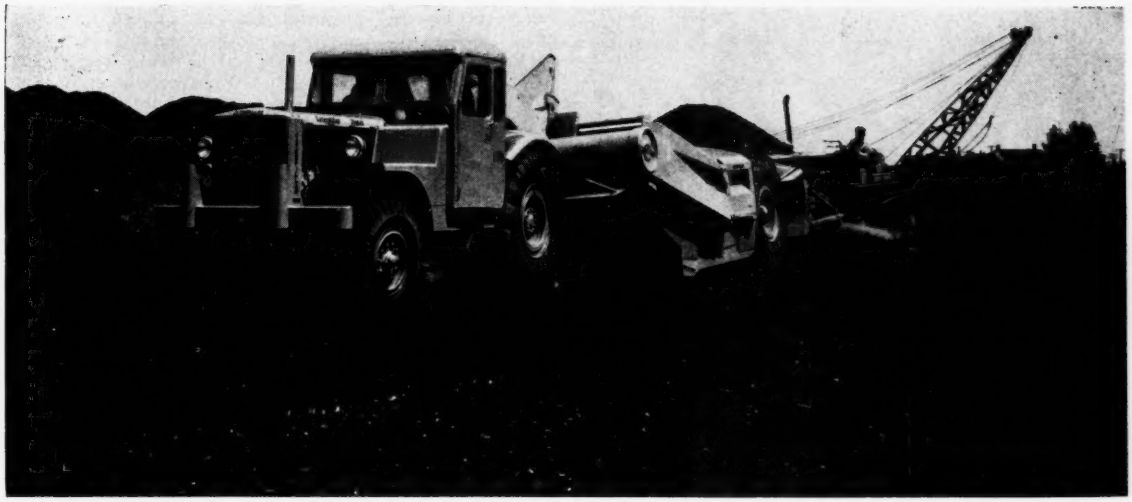


Fig. 3. Four-wheel rubber-tired tractor with large capacity scraper being push loaded on stock pile by crawler tractor. Boom rigged on crawler for use on miscellaneous operations about plant when tractor is not engaged in coal storage operations

generally considered the basic piece of equipment for operations of this type. Supplementing the crawler are "bulldozer" blades, cable and hydraulic operated, angle and straight types mounted directly on the tractor; bottom-loading scrapers or "carryalls" designed to be pulled behind the tractor on large pneumatic tires; self-powered, bottom-loading scrapers on pneumatic tires that have sufficient power to carry the loaded scraper at high speed over fairly steep grades and to unload it, but which require a push or a snatch pull from the "cat" to load from the bottom; bottom, side or rear-dumping wagons on pneumatic tires pulled by the same types of rubber-tired tractor units that pull the self-powered scrapers.

It should not be overlooked that this type of equipment has been developed primarily for the construction industry and that advances and innovations will first be found in that field. At the same time, the construction industry provides a severe proving ground for any new equipment, and any devices which find acceptance in that highly competitive business will readily meet the requirements of coal handling in the utility industry. It is suggested, therefore, that anyone who has the responsibility for selecting equipment for coal storage operations keep closely in touch with the construction field through their publications, road shows, and the like.

Most operations by utility companies are scaled to handle coal into or out of storage at the rate of at least 500 tons per day. Such operations involve the application of the heavier types of equipment. We will, therefore, devote our attention largely to these types.

Until recently there has been little choice in the equipment available

Fig. 4. Rubber-tired heavy tractor unit equipped with bulldozer blade spreading and compacting coal on storage pile

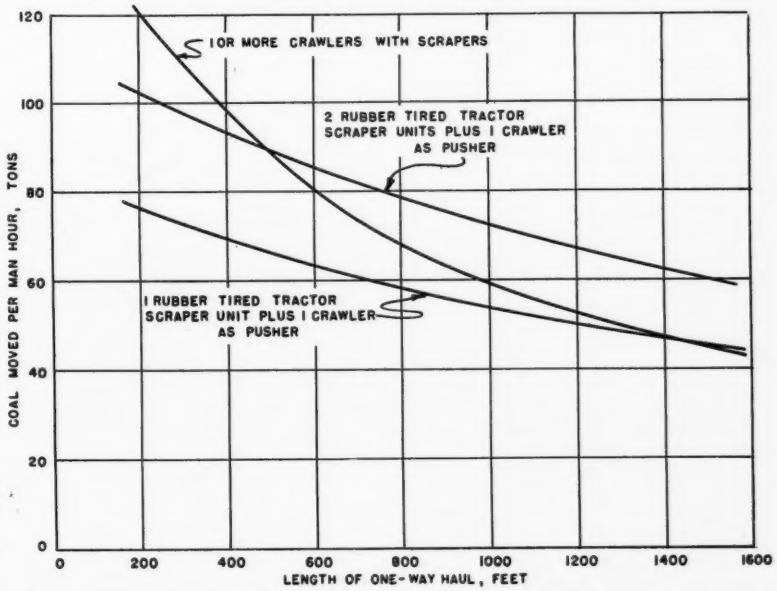


Fig. 5. Curves showing performance of rubber-tired and crawler tractor equipment handling coal. Based on 15-cu yd average scraper capacity, maximum crawler tractor speed 5 mph; maximum rubber-tired tractor speed 15 mph; 48 min per hr actual operating time

Fig. 6. Loading rubber-tired tractor scraper unit from loading bin, eliminating use of pusher

for this operation. Crawler tractors in the 20-ton class were manufactured almost solely by one manufacturer and the supplementary equipment, although produced by several companies, was well designed to operate with one make of tractor.

"Bulldozer" or "angledozer" blades were produced by several manufacturers. Some operated by cables, some by hydraulic systems. Scrapers, or "carryalls," were designed almost universally to be handled by crawler-type tractors at relatively low speeds. These were operated as full trailers with front and rear rubber-tired wheels on the scraper connecting to the tractor by a drawbar and by a pair of cables which serve to operate the loading and unloading mechanism. This combination is shown in Fig. 1.

Designs by the various manufacturers differed chiefly in the cutting edge used in loading and the ejecting mechanism used for unloading. Early practice was to be to equip the rear end of the larger scrapers with dual tires on each axle, providing an almost complete rolling surface over the width of the rear end of the scraper. More recently the practice has seemed to be to use larger tires on the rear, but to use only two tires. At the close of the war, only one make of self-propelled, fully-rubber-tired scraper was in general use. (A second make was in use, but limited largely to the west coast.) For large coal handling operations, its capacity was small. It required the assistance of a pusher to load it and, unless the hauls were very long and the operations extremely heavy, it was not found economical for coal handling purposes.

Recent Developments in Equipment

Recently, other manufacturers of crawler tractors have entered the field with equipment of the heavier types, so that there is now a selection of crawler equipment. One make is equipped with a hydraulic clutch or "torque converter," which promises to reduce the difficulties of operation and maintenance of full selective gear transmissions, besides giving smoother operating characteristics when pulling, bulldozing, and the like. All are Diesel-engine powered and have about the same unit load per square foot of track surface in contact with the ground. Maximum speeds range from five to six miles per hour. A typical unit of this type is shown in Fig. 2.

One manufacturer who, until recently, produced power units only in connection with his self-propelled scraper equipment, has entered the separate tractor field and is offering a tractor on large pneumatic tires comparable in draw bar pull to the heavier crawler type tractors at low speeds but with top speeds of from 12 to 15 mi per hr. Development of this unit is to be watched with interest, for it will, if successful, solve the problem of high speed combined, when necessary, with high tractive effort plus the advantage of full pneumatic tire mounting, all features desirable for coal storage operations.

Several manufacturers have now entered the field with rubber-tired, self-propelled equipment and capacities have been stepped up to the point where equipment of this type may be considered for substantial coal handling operations. Some of this equipment is furnished with four-wheel tractors, with power to the rear tractor wheels through differential gearing. These steer by conventional methods through the front wheels. Other types are equipped with two-wheel driving units, steering through clutches and brakes or through hydraulic mechanism operating on a yoke or bull wheel centering on the king pin. A typical four-wheel tractor and scraper combination is shown in Fig. 3.

Further Probabilities of Equipment

The field to which this equipment is normally supplied, the construction industry, is one that fosters a very high competitive development; and manufacturers are offering new varieties of equipment larger in size and more versatile in performance at bewildering rates. It is to be expected, therefore, that any study made at this time may become outdated by the time such studies can be examined. Nevertheless, with extremely rapid developments, unless it is desired to accept many of the development problems and work them out with the manufacturer, which very frequently turns out to be at the buyers' expense, most utility companies prefer to go slow in accepting any innovations. The trial field for the equipment in the construction industry is such that its weaknesses will show up in a very brief period, and it is well to wait until equipment has passed through such a trial period before accepting it for the requirements of high reliability dictated by the utility coal handling problem.

To be watched with interest, at the present time, is the development of the two-wheel vs four-wheel tractor in the self-propelled equipment. Another development, mentioned above, which may well receive consideration, is the full rubber-tired separate tractor for bulldozing and hauling service. This unit is well illustrated in Fig. 4. If this unit establishes itself, many of the problems of balance of equipment size may be solved directly, since the tractor unit is independent of the scraper.

At the present time, this equipment is produced by only one manufacturer in sizes suitable for most utility coal handling operations. It is more expensive than the crawler tractor and, as originally designed, has been developed chiefly for bulldozing operations. Most of the information on the performance of the equipment on earth is controversial; and although the writer has witnessed a successful demonstration of the equipment on coal, he has seen no data on its actual performance on this material.

Operating Performance to be Expected

With the various equipments now available, it is in order to consider the relative economics of the rubber-

(Continued on page 114)

Maintenance of Electronic Regulators

Do electronic devices mystify you? Do you feel that regulators and other control devices using electronic tubes are too complicated for you to service and maintain? If you do, maybe you had better read this article by Mr. Gayek of the General Electric Co. He tells you in very simple language how to go about taking care of this type of equipment—how not to be scared by them merely because they contain a few electronic tubes

By H. W. GAYEK
Control Engineering Division, General Electric Company, Schenectady, N.Y.

NOT SO MANY YEARS ago the word "regulator," in electrical parlance, meant a carbon stack or vibrating contact device connected in the field circuit of a generator and used for holding the generator terminal voltage constant despite variations in load. Today, the word refers to a number of devices having a multitude of uses and applications. There are regulators for voltage and for current, for speed and position, for temperature and pressure, for flow and thickness, for power and power factor. As a matter of fact, there is a regulator for nearly any variable that anyone has ever had the desire to hold constant.

To the carbon stack and vibrating contact regulators there have been added other types of electromagnetic devices, as well as completely magnetic regulators, magnetic-rotating-amplifier regulators, and even electro-magneto-hydraulic and electro-magneto-pneumatic regulators.

Since one of the chief functions of a regulator is to amplify, it was inevitable that the electronic tube, which was developed especially for that purpose, would be applied in the regulating field. Indeed, so well does the electronic tube serve this function that regulators employing electronic tubes—electronic regulators—find their chief use in applications requiring degrees of regulating accuracy that cannot be met easily with other types of devices. Further impetus is given to the use of electronic regulators beceause of the versatility and the ease with which special functions can be incorporated in this type of equipment.

These advantages — high accuracy and versatility—make electronic regulators particularly suitable for use in controlling continuous processes, such as the making of paper or the rolling of steel, where small differences in speed, say between successive sections of the process, would result in an unsalable product. By improving regulating accuracies, electronic regulators permit the manufacture of higher quality products and allow higher production rates.

With increased production, shutdowns due to equipment failures become more important, and the maintenance problem becomes a critical one. This article describes some factors of importance in the maintenance of electronic regulators. The discussion is confined to the astatic, or proportional, type of regulators (output continuously proportional to input). Both all-electronic (thyratrons as the power element) and electronic-rotating amplifier (rotating amplifier as the power element) regulators are considered.

Preventive Maintenance

Once a regulator has been installed and is operating satisfactorily, the problem of keeping the equipment operative resolves itself into two parts: preventive maintenance, and servicing in the event of failure.

Preventive maintenance, like preventive medicine, consists of periodically giving the equipment a physical examination for the purpose of determining and correcting weaknesses which may cause ultimate failure. In the case of electronic regulators, which contain few moving parts — perhaps a time-delay relay or an occasional control relay —preventive maintenance is relatively simple. It consists of no more than (a) checking the panels for connections which might have become loosened owing to vibration, (b) blowing out accumulated dust and dirt, and (c) testing the tubes to forestall the possibility of tube failure during operation and the resulting unscheduled shutdown of the equipment. Nevertheless, it is desirable to inspect the equipment on a definite schedule, lest it be for-

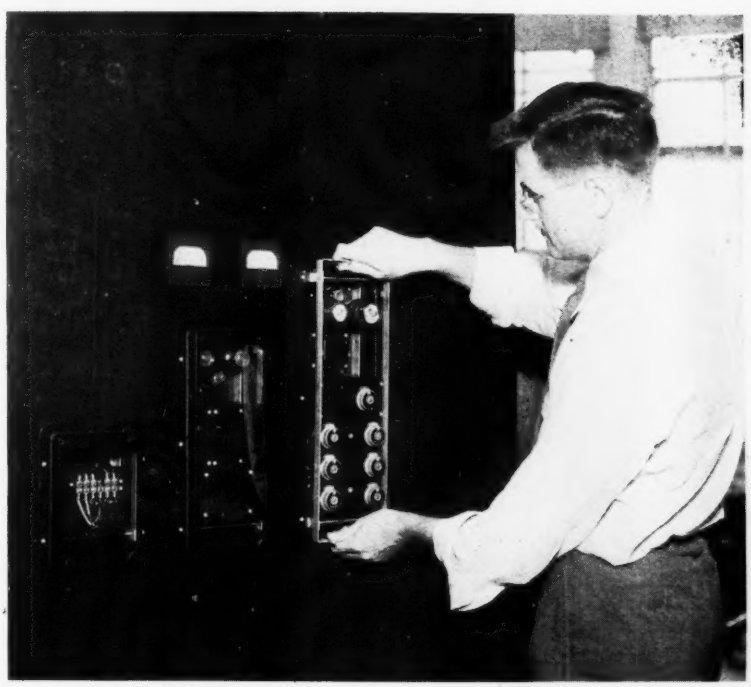


Fig. 1. An example of an electronic regulator specially designed for quick replacement with spare unit to minimize shutdown time in event of failure. Unit at left is special feedback panel, center unit is power and reference voltage supply, and unit being inserted is voltage and power amplifier. The three units comprise an electronic-rotating amplifier amplidyne regulator similar to that shown diagrammatically in Figs. 2 and 3

gotten and never checked. Once every two months is a reasonable schedule. However, unusual conditions, such as a particularly dusty location or unusual production demands which allow only very infrequent shutdowns, may shorten the length of the period between inspections. Special attention should be given to the main adjusting rheostats on which dirt and grease frequently cause poor contact between brush and winding and result in erratic operation.

While there is nothing ambiguous about tightening connections or cleaning a panel, the subject of tube testing and predicting tube failures is a controversial one and deserves special discussion. Relatively speaking, tubes are the expendable items in electronic regulators.

Three types of electronic tubes are in common use in electronic regulators—vacuum tubes of the radio receiving type; cold-cathode glow tubes, sometimes called voltage-regulating tubes; and mercury- or gas-filled thyratrons. Each of these types is subject to different types of failure.

Vacuum tubes, the "brain tubes" of an electronic regulator, may fail by open-circuiting of the heater, by marked change in tube characteristics owing to loss of emission or shifting of control electrode wires, or occasionally by short circuits between electrodes within the tube envelope. Heater open-circuiting and electrode short-circuiting are unpredictable and generally result in rendering the regulator completely inoperative. Fortunately, heater circuits become open mainly during the preparatory tube warm-up period following a shutdown, and electrode short-circuits are rare. Heater open-circuiting can be minimized by keeping heater power on the tubes continuously, thus avoiding the mechanical stresses resulting from thermal expansion which occurs when power is applied to cold tubes.

Changing of tube characteristics is a gradual process which in extreme cases results in reduction of regulating accuracy and sometimes, depending on the system and the type of stabilizing circuits incorporated in the regulator, in a tendency toward hunting.

Tube characteristic changes occur as the result of reduction of cathode electron emission as the active cathode material is used up or flakes off. These changes may be detected by testing the tubes periodically, say once every two months, in a tube tester designed to measure transconductance. A drop to about 70 per cent of its initial, new-tube value may be taken as the criterion for replacing the tube. Similarly, an abrupt reduction in transconductance since the last test may be an indication that the tube is wearing out. This last criterion must be applied with caution, however, since many types of tubes, if not pre-aged, exhibit high rates of change of transconductance during the initial few hundred hours of operation, usually levelling off after about 2000 or 2500 hr. At any rate, all new tubes should be tested when first installed and a careful record made of their transconductance during this and subsequent tests. No tube should be discarded merely because it is old.

The useful life of a glow tube is limited by the characteristics of its cathode, which becomes used up during operation, and to some extent by absorption of the gas by the tube electrodes. End of life is defined primarily by an increase in starting and normal tube voltages and by a reduction in the ability of the tube to maintain its own voltage constant with changes in power-supply voltage. It is manifested by lack of the characteristic orange or violet glow, by supernormal tube voltage, or by a tendency toward wandering of the variable being held constant by the regulator. The simplest test consists merely of measuring the voltage across the tube during operation. A high-resistance voltmeter should be used in order to avoid overloading. No tube tester is required. A gradual rise in voltage between successive tests indicates the approach of the end of life and the need for replacement. Here again it is desirable to maintain careful records of tube voltages measured during periodic tests.

Thyratrons, the "power" elements of electronic regulators, are hot-cathode devices containing either an inert gas or liquid mercury which vaporizes during operation. As in glow tubes, one criterion of tube failure is a marked rise in arc drop, the voltage from cathode to anode, when the tube is conducting. This voltage varies somewhat with load current, vapor or gas pressure, and the condition of the cathode. In good tubes it runs between 10 and 30 v at rated peak current. While thyratron tube testers are commercially available, the best test for a questionable

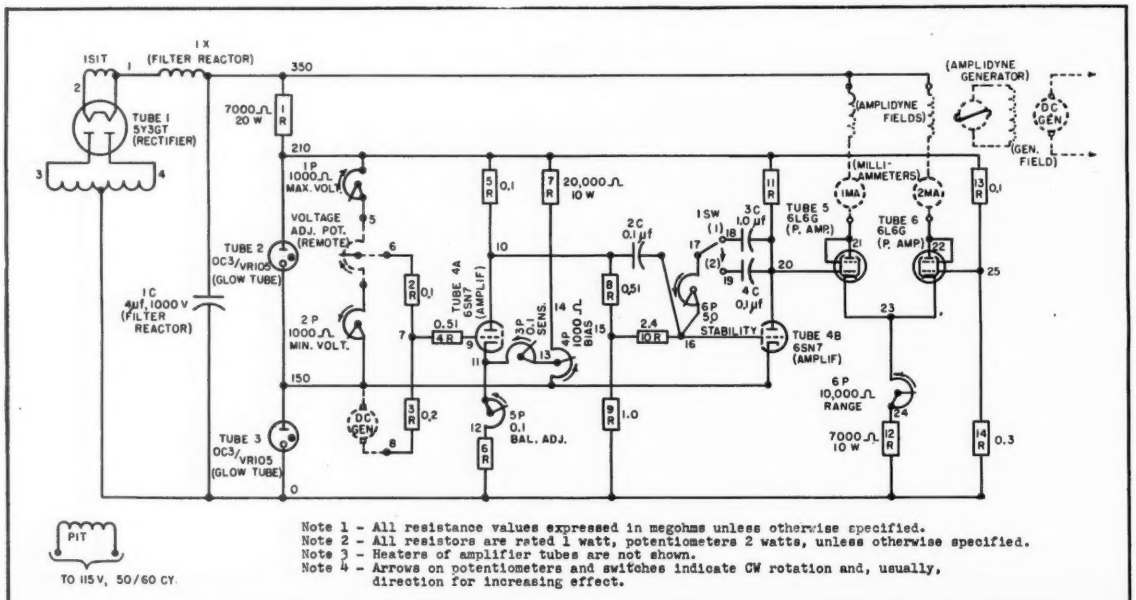


Fig. 2. A typical elementary diagram for a d-c voltage regulator. This diagram illustrates some of the commonly used schematic symbols. Items shown in brackets have been added for descriptive purposes; they do not normally appear on diagrams. Devices shown dotted are portions of the regulating system not mounted on the regulator panel

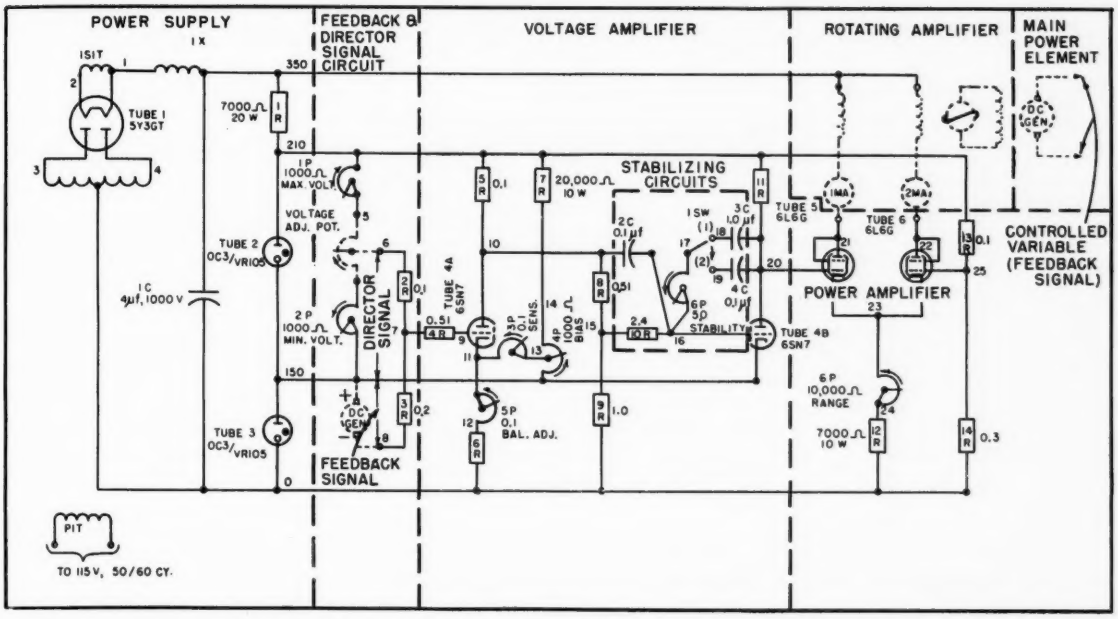


Fig. 3. The elementary diagram of Fig. 2 blocked out to show the main component functional parts of the regulating system

tube is to replace it with a tube known to be good and check for an improvement in performance. Indeed, this is by far the best test for vacuum and glow tubes as well as for thyratrons. One word of caution: mercury thyratrons are highly sensitive to temperature. Good tubes will perform erratically if operated in high or low ambient temperatures. It is extremely important to provide the ventilation required to allow the tubes to operate within the temperature limits specified by the tube manufacturer. Gas-filled thyratrons, vacuum tubes, and glow tubes operate satisfactorily over a much wider range of temperatures.

High discard rates for vacuum and thyratron tubes may indicate some chronic, unhealthy condition. A common one is high or low filament or heater voltage. It is a good idea to measure filament voltages during the periodic maintenance check. Voltages which are more than 5 per cent above or below rated value may indicate an abnormal line voltage which should be corrected by use of a suitable control transformer.

Servicing

Like every piece of equipment, an electronic regulator, no matter how well cared for, may sometimes fail in service. If the regulator is constructed mechanically in a manner which allows it to be disconnected quickly and replaced with a spare (Fig. 1), the faulty unit can be checked on the workbench at the serviceman's leisure without tying up production. More often, however, the faulty regulator must be serviced on the spot.

Servicing an elecronic regulator is exactly like servicing any piece of equipment. It consists of (a) observing the symptoms of the malfunction, (b) listing, mentally at least, all the possible causes of the trouble, (c) eliminating, one by one, these possibilities by test and measurement until the cause is isolated, and, (d) eliminating the cause by replacing the defective component or doing whatever else may be necessary.

In many cases the time required to restore service is very important from an economic standpoint. To perform a service job in the minimum possible time, the man charged with the responsibility for maintenance of the equipment must be well prepared. He must be familiar with the theory of operation of the equipment. He must keep in a readily accessible file all the up-to-date blueprints, the instruction book, the maintenance records, and all other information pertinent to the equipment. He must have on hand and in good working order the basic servicing instruments as well as a reasonable supply of spare parts. A knowledge of the theory of operation, together with reference to the diagrams for the equipment, particularly the elementary, or schematic, diagram, gives him an inkling of which portions of the equipment to investigate for sources of trouble. Instruments allow him to locate the seat of the trouble, and spare parts permit him to make the repairs necessary to restore service.

Knowledge of the theory of operation is gained by studying the elementary diagram for the regulator—a diagram provided for all but the very simplest of devices, for which the connection diagram suffices. An elementary diagram serves to show, by use of schematic symbols, the functional arrangement of the parts of the regulator. Usually this arrangement bears no relationship to the actual arrangement of the component parts on the physical panel. Fig. 2 shows a typical elementary diagram.

An instruction book for the regulator is, of course, a great help in learning how the equipment operates, particularly if the book contains a section on theory of operation.

One unfamiliar with industrial electronic equipment may find understanding the elementary diagram tough sledding. His first obstacle will be recognizing the symbols used. Fortunately, most manufacturers of industrial electronic equipment use American Standards Association symbols. These are described in ASA Standards Z32.3, "Graphical Symbols for Electric Power and Control," and Z32.10, "Graphical Symbols for Electronic Devices." These booklets are available for a small fee from the American Standards Association, 70 E. 45th St., New York 17, N. Y.

His next problem will be understanding the operation of some of the less familiar devices commonly used in electronic regulating systems. Typical devices are vacuum, regulator, and thyratron tubes; saturable reactors; thyrite resistors; amplidyne generators; and so on. There is available some excellent literature describing the theory of operation and common uses of such devices. A few references are listed at the end of this article.

Finally, the man must determine the functions which the various com-

(Continued on page 120)

Reducing Boiler Sludge With a Silica Equilibrium

Part I:—Another useful tool for combating formation of deposits in boilers—the much-despised and much-feared Silica . . . By proper use of silica, under good control, where careful diagnosis indicates it, sludge in boilers may be reduced or eliminated . . . Hot-process lime-soda softener operation may be improved . . . This first part of a two-part article shows in detail why the unorthodox procedure of adding silica to boiler water may be beneficial under right conditions, harmful if misapplied . . . In Part II, in a future issue, interesting case studies will be shown

By J. W. WELSH Director of Engineering Service, Hall Laboratories, Inc.

ENGINEERS are quite silica conscious today because of the problems of silica, sodium silicate, sodium aluminum silicate and sodium iron silicate scale in boilers and silica deposits in turbines, that have come with operation at higher pressures, higher ratings and higher rates of heat absorption. As a consequence, fear of silica has grown to vast proportions—it is looked upon as the primary evil of boiler water conditioning, and much has been written on silica removal procedures. Admittedly, there are many cases where silica causes severe difficulty and its removal practically to the point of elimination is not only justified, but essential. Nevertheless, it is the object of this paper to show that the unorthodox procedure of adding silica to the boiler water can be greatly beneficial under certain conditions, while silica removal can be definitely harmful if misapplied.

The all-out attack on silica during the past decade has included lowering of its concentration in the boiler water by every practicable means:—increased blowdown, chemical treatment of boiler-feed makeup and evaporator feed in suitable equipment, [1] chemical treatment of boiler water [7, 9, 10] and avoidance of contamination of condensate. More recently, an effort has been made to live with silica by maintenance of a potassium equilibrium in the boiler water. [4] In numerous instances where silica removal has not been a necessity but has been practiced, and where similar attention has not been given to elimination of magnesium, difficulty has been encountered with the formation of soft, adherent deposits in which magnesium phosphate is a significant constituent. Such deposits have also been plaguing engineers in far more plants where no attempt has been made to remove silica but where its normal concentration in the boiler feed water is low in relation to the magnesium concentration.

The Problem Recognized

For more than twenty years since the introduction of the phosphate equilibrium to boiler-water chemistry [2] it has been common practice to maintain this equilibrium for precipitation of all calcium as non-adherent calcium phosphate sludge. It was assumed that magnesium, generally present only to a fraction of the calcium in the feedwater, would be precipitated as the silicate, hydroxide or phosphate. It has been so precipitated, but experience has shown that the sludges containing magnesium phosphate [$Mg_3(PO_4)_2$], hydroxyphosphate [$Mg_3(PO_4)_2.Mg(OH)_2$] or hydroxide [$Mg(OH)_2$] tend to adhere to boiler surfaces. In contrast, the virtually amorphous and extremely insoluble magnesium silicate precipitated from an alkaline boiler water forms and remains dispersed in the water as a sludge, which is readily removed by blowdown. It is probably its great insolubility that accounts for the non-adherence of magnesium silicate sludge, for complete precipitation will occur quickly in the body of the boiler water.

All of these factors have long been known. [3] As analyses of deposits from dirty boilers showed high magnesium, low silica and more than enough phosphate to combine with the calcium as calcium phosphate, and boiler water samples remained clear when they should have been cloudy with sludge, it became increasingly apparent that the concentration of silica in these boiler waters would have to be increased sufficiently to insure precipitation of the magnesium as magnesium silicate.

As would be expected, the recommendation that silicate (as sodium silicate) be added in controlled amount met resistance at first; and it was not until 1942 that the engineer at a plant in Buffalo, N. Y. agreed that a slightly increased silica concentration represented a small risk to take if the heavy sludge deposits in the boilers could be eliminated or greatly reduced. Success was immediate. Sludge showed up in the boiler water at once and subsequent inspections indicated the boilers to be in good condition internally.

With this initial example to encourage them, other operators accepted the heretical recommendation that silica should be fed to their boilers. [6] Today a consistent and convincing mass of practical evi-

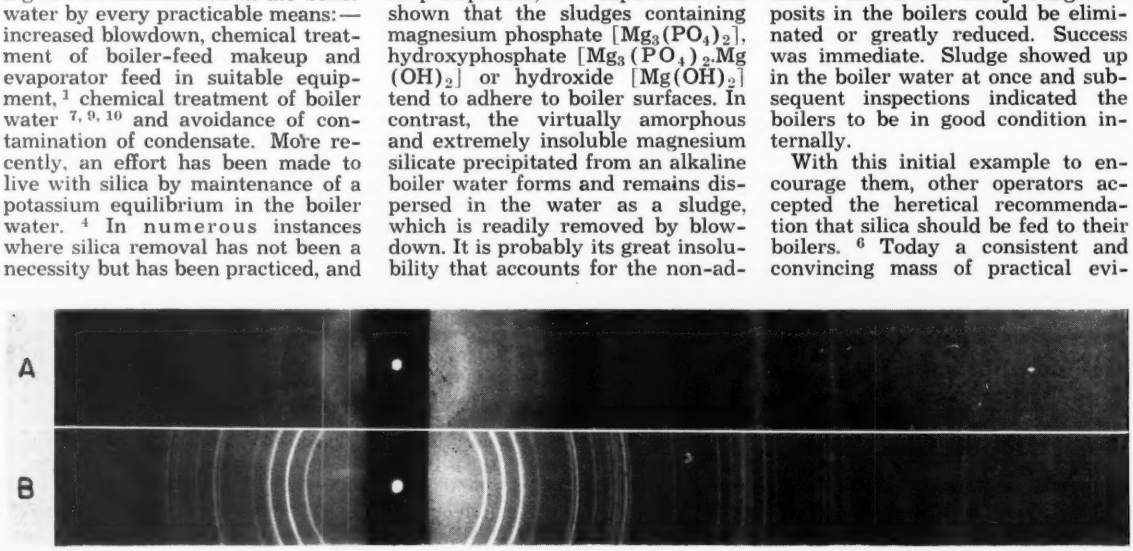


Fig. 1. A—Diffuse X-ray diffraction pattern of serpentine indicates nearly amorphous condition. B—Sharp pattern of magnesium hydroxyphosphate indicates compound well crystallized

dence shows that silica, used intelligently, can be an excellent servant.

Guideposts

A familiar and typical guidepost pointing to lack of sufficient silica with respect to magnesium is given in the accompanying Table I. Analysis of the relatively soft, adherent sludge indicates it to be largely calcium phosphate, magnesium silicate and magnesium phosphate, the substantial amount of this third constituent being more than enough to account for the adherent nature of the deposit.

Final decision as to whether deficient silica is responsible for adherence of sludge must be made upon the basis of the composition of the sludge. Nevertheless, there are other guideposts, such as lack of suspended material in boiler-water samples that should contain an appreciable amount considering the hardness of the feed water and extent to which concentration occurs, insufficient silica in the makeup water to combine with the magnesium as serpentine, and low boiler-water silica concentration.

Silica Equilibrium

As previously pointed out, it is now standard practice to maintain the phosphate equilibrium in the boiler water to insure precipitation of calcium as calcium phosphate (hydroxyapatite). Why not maintain a silica equilibrium to insure that magnesium silicate, rather than magnesium phosphate, hydroxide or hydroxyphosphate, will be the solid phase? This is exactly the basis upon which silica conditioning has been applied.

Table I. Principal constituents of thin, soft scale from feeder tube to side water-wall header of 440-psi, 4-drum, bent-tube boiler. High magnesium phosphate content shows effect of deficient boiler-water silica

	Per cent
Calcium phosphate as hydroxyapatite $3Ca_3(PO_4)2\text{-}Ca_3(OH)_2$	63
Magnesium phosphate $Mg_3(PO_4)_2$	23
Magnesium silicate as serpentine $3MgO.2SiO_2.2H_2O$	12

What form of magnesium silicate is precipitated from the boiler water? It is believed to be serpentine ($3MgO.2SiO_2.2H_2O$), as experiments described in the literature [5] and X-ray diffraction patterns, Fig. 1, as well as chemical analyses on hundreds of samples, indicate this to be the stable phase in boiler water. Nevertheless, there may very likely be adsorption of silica on magnesium hydroxide as well as chemical combination. This is unimportant from a practical standpoint, as results are of greater concern.

What does the maintenance of the silica equilibrium involve? Silica concentration in the boiler water must be high enough in relation to the concentrations of hydroxide (OH) and phosphate (PO_4) that magnesium silicate and not magnesium hydroxide, hydroxyphosphate or phosphate will separate as solid phase. Exact concentrations cannot be defined because of lack of sufficient data on the composition of the compounds formed and on the solubilities thereof. Nevertheless, in plants using treated or raw makeup water, experience has indicated that suitable results can be obtained over a wide range of alkalinity if the ratio of silica (SiO_2) to phosphate (PO_4) in ppm. is not less than about 0.5.

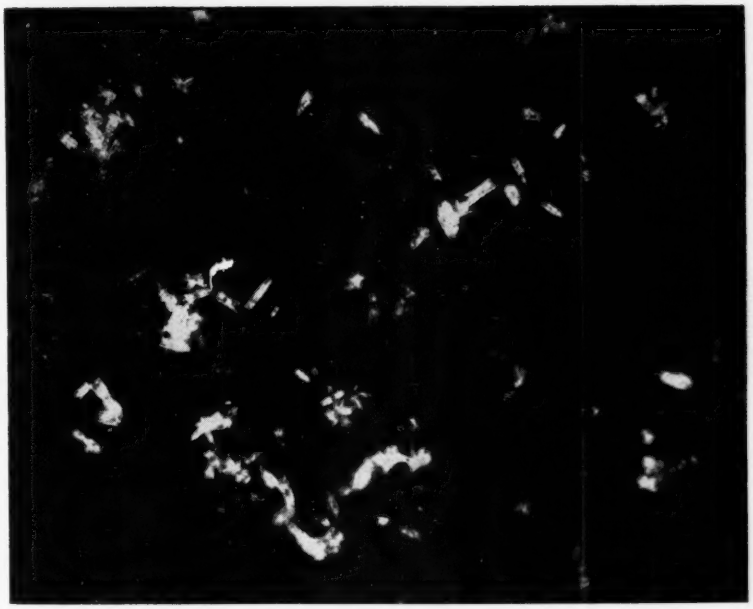


Fig. 2. Photograph with polarized light of magnesium hydroxyphosphate crystals—X250

It is obvious that, with waters requiring silica addition, the application of a silica removal process can be decidedly harmful. If pressure, rating and heat absorption conditions or danger of silica deposition on turbine blades, dictate reduction of silica to extremely low concentration, then similar attention must be given to minimizing magnesium and boiler-water phosphate concentrations or difficulty is bound to eventuate.

Methods of Adjusting Silica-to-Magnesium Relationship

There are three general procedures for adjusting the ratio of silica to magnesium when it is indicated to be low by one or more of the guideposts described. All are controlled by regulating the silicate (water glass or other alkali-metal silicate) feed to establish the desired concentration of silica in the boiler water. Logically, in all cases, boiler-water phosphate concentration should be kept as low as possible, consistent with continuous maintenance of some available phosphate in the water, so as to give magnesium every opportunity to combine with silica and minimize the required concentration of silica in the boiler water.

Addition of Silicate to Boiler Water: It is an interesting experience to institute silicate conditioning in boilers that are dirty with magnesium phosphate. Magnesium is taken away from the phosphate by the silicate and if heavy sludge deposits are present, enough sodium phosphate is formed by the reaction to result temporarily in great reduction in the phosphate feed to the boilers. This is definite proof that with suitable boiler-water conditions the magnesium goes to the silicate rather than to the phosphate.

In plants where boiler-feed makeup is raw water, or where condenser leakage or other condensate contamination sets up an undesirable relationship between magnesium and silica in the boiler water, the alkali-metal silicate needed to supplement the silica naturally present in the raw or contaminating water can be fed to the boiler water. The same procedure can be followed with base-exchange, cold lime-soda or hot lime-soda treated makeup, but with the last the usual practice is to add the silicate to the softener chemical-mixing tank. This will be discussed under hot-process softening.

Base Exchange Softening:—With base-exchange softening, magnesium concentration of the makeup water is normally reduced to a very low point and thus adjustment in the silica to magnesium relationship is accomplished. Of course, if silica concentration of the water is still too low, some silicate can be used in the boilers and this has been necessary in at least one well-operated plant. [8]

Base-exchange softening is quite suitable for waters which are relatively low in silica but is not always a satisfactory procedure. Consider

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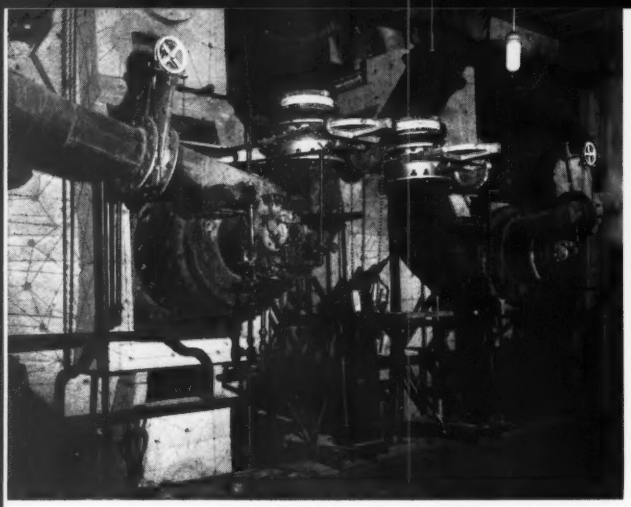


Fig. 1. View looking towards front of Boiler No. 13, Dow West Side Power Plant, showing two horizontal cyclone burners. In center, pipes conducting primary air and coal mixture down from coal conditioner to tangential burner

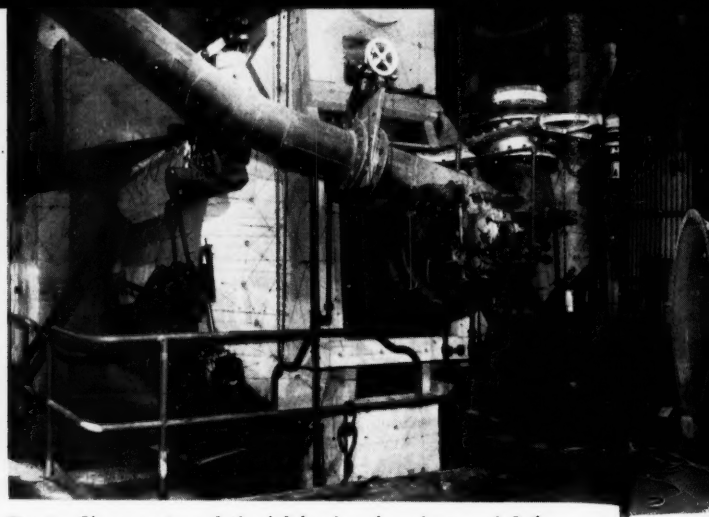


Fig. 2. Close-up view of the left-hand cyclone burner of Boiler No. 13, West Side Power Plant, showing, at upper left, secondary air duct leading to side of cyclone burner, with control drives for operation of secondary air damper at inlet to burner

Dow Installs First Industrial Cyclone Burner Units

By **CHESTER R. EARLE** Managing Editor, POWER GENERATION

THREE INDUSTRIAL steam generating units, to be fired with crushed coal by the new cyclone burner, are at present under erection at two power plants of Dow Chemical Co. at Midland, Mich. The first of these units, Boiler No. 13, to be described here, is being installed at the West Side Power House of the company; and at this writing is nearly ready to go into operation.

Boiler No. 13 is a Babcock & Wilcox Co. steam generating unit, as shown in Fig. 7, with a rated capacity of 400,000 lb of steam per hr, generating steam at 1250 psig and 900 F, and fired with crushed, not pulverized, coal, by two horizontal cyclone burners.

The furnace of this unit operates under pressure, entirely under forced draft, no induced-draft fans being installed; the boiler and heat absorbing surfaces are so designed and arranged that they can be cleaned efficiently by chemical methods; primary and secondary continuous-tube superheaters and economizers are used; the entire unit occupies space originally provided for one of much lower capacity; the entire unit is designed for overall efficiency of 90 per cent and can burn a very wide range of coal. Since most of the ash is trapped and discharged in the furnace slag, boiler slag cleaning and flyash emission are at a minimum.

General Development of New Plants

Another separate power plant, the South Power House, about a mile away from the West Side plant, is now being constructed. The first two steam generating units to be installed there, Boilers 14 and 15, will also be

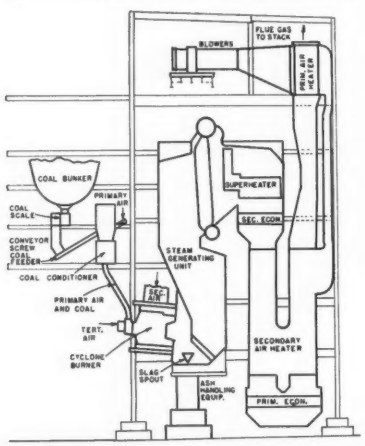


Fig. 3. Schematic outline diagram showing approximate relative positions of principal elements of Boiler No. 13

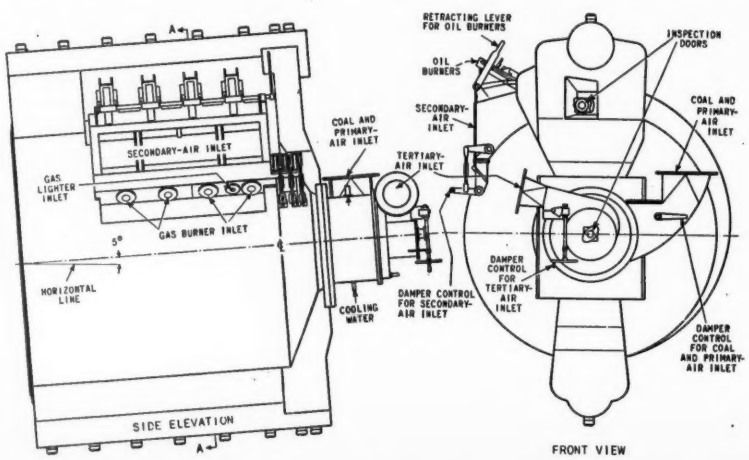


Fig. 4. Assembly details of one of cyclone burners on Boiler No. 13

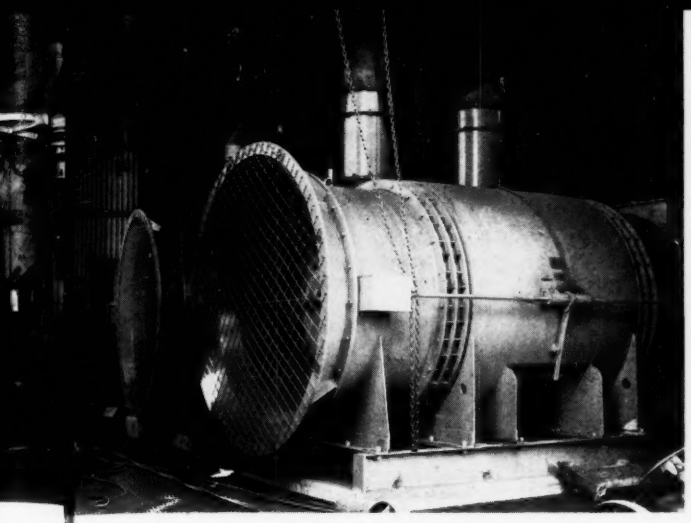


Fig. 5. Construction view of the three forced-draft blowers providing combustion air for the cyclone burners of Boiler No. 13. Two blowers will carry boiler, one spare; each rated at 52,500 cfm at 77 in. H_2O discharge pressure

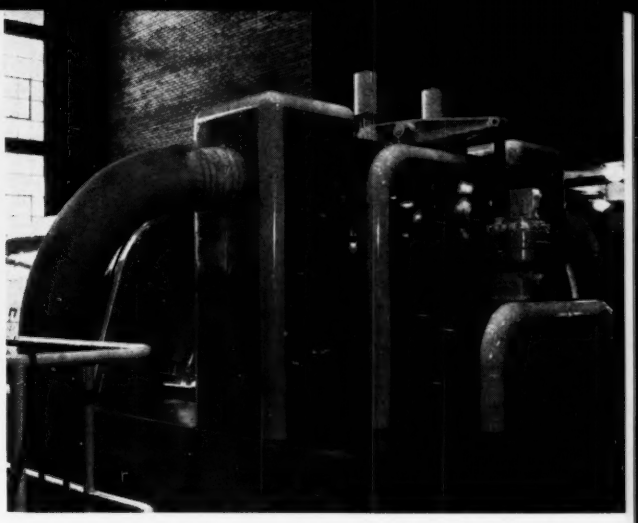


Fig. 6. View of new Turbine No. 14, rated at 15,000 kw, 0.8 p.f., throttle steam 1250 psi, 900 F. exhaust at 400 psi 700 F to 400 psi steam system, see Fig. 9. In same turbine room are installed turbine-generators Nos. 6 and 9, which are 400-psi units; also No. 7

two 1250-psi, 900-F units each of 400,000 lb per hr capacity, each fired by two cyclone burners, and similar to Boiler No. 13. In the new South power plant will also be installed a 30,000-kw, 1250-psi, 900-F double-extraction turbine generator set now on order from Westinghouse, as noted in the January 1, 1948 issue, page 66.

The West Side Power Plant, where the new No. 13 boiler is being installed, is the latest one* serving the Dow Chemical Co. at Midland. This power house, Fig. 13, also contains Boilers 7, 9 and 12 and turbine generators Nos. 6, 7, 9 and 14. Number 14 is a 1250-psi unit exhausting to the 400-psi steam system, while Nos. 6 and 9 are 400-psi units discharging to vacuum. Turbine No. 14 is a new Westinghouse unit, rated at 15,000-kw, 0.8 p.f., Fig. 6, and put into operation in 1948.

Objectives of Boiler No. 13 Design

Plans for the new boilers were begun during the war. Following the successful development and operation of the horizontal cyclone burner at the Calumet Station of Commonwealth Edison Co. in Chicago, (described by Grunert, Skog and Wilcoxson in *Transactions of the ASME*, August, 1947), it was decided to use the cyclone burner for the three contemplated new units. Primary objectives of the Dow engineers were:

1. To keep the ash and slag in the furnace where it belongs, thus minimizing or eliminating slag cleaning and flyash emissions; 2. To burn high-volatile coal of relatively high ash content, with low ash-fusion temperature, without pulverizing, thus decreasing costs of coal preparation, maintenance and operation; 3. To burn a wide range of available coals; 4. To design a boiler with small tubes that could be cleaned by chemical cleaning methods, thus permitting a different arrangement of the various heat-absorbing surfaces; 5. To obtain a boiler of high effi-

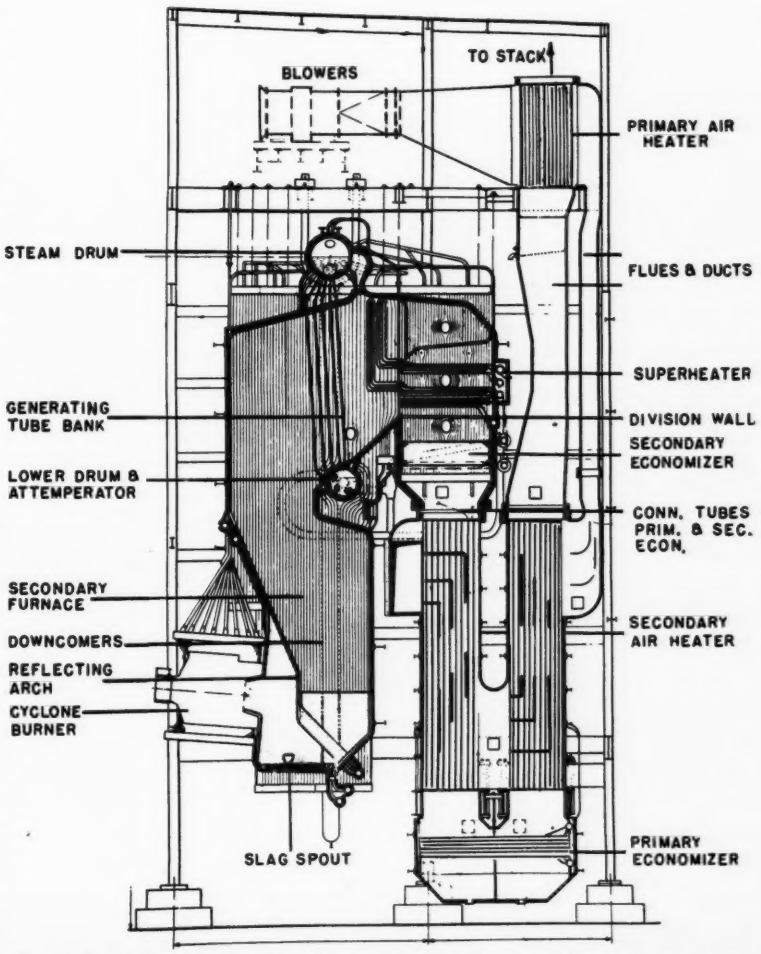


Fig. 7. Detailed cross-section of Boiler No. 13, West Side Power House, showing location of cyclone burners, construction of furnace. Unit rated at 400,000 lb per hr of 1200-psi, 900-F steam

* One of the power plants, the NT Plant, was described by this writer in *Power Plant Engineering*, May 1, 1930. At the time that article was written in 1930, the total generating capacity installed was approximately 38,000-kw. Today, the total installed generating capacity is close to 90,000 kw; and installation of the new 30,000-kw unit at the South Side Plant will raise this total to 120,000 kw.

Fig. 8. View of main steam drum, Boiler No. 13, under construction, showing 60-in. 1300-psi drum with one of 21-in. downcomers; similar downcomer on other end

ciency; 6. To permit pressure operation of the furnace, eliminating induced-draft fans; 7. To reduce space occupied by entire steam generating unit.

Proper Water Supply Required

However, before final plans could be made to install the cyclone-burner units, provisions had to be made for proper water supply. It was desirable to use demineralized feedwater because of the boiler design and the fact that the make-up requirements range between 50 per cent and 60 per cent in the Dow plant.

To supply this, a new water treatment plant with a capacity of 2000 gpm, of demineralized water, utilizing the Belco system of demineralizing under complete automatic control, has been constructed near the new South power plant. Raw water for this treatment plant is drawn from a new regional water supply system recently completed for the cities of Saginaw and Midland, Mich. This system draws water from Lake Huron at a point about 40 miles north of Bay City, Mich. From this system Dow Chemical Co. purchases 7,000,000 gpd of water for process and boiler feed and many cooling applications (except for such uses as the fire-fighting system and similar uses where purity is not a factor, for which water from the Tittabawassee River can be utilized). Details of this new water system and the new demineralizing plant will be given in a future article.

New Boiler Design

Arrangement of the new Boiler No. 13 is shown in schematic outline in Fig. 3 and its details in Fig. 7 and 11. The boiler has two drums connected by a bank of convection tubes as shown, the upper or steam drum being 60-in. in diameter. The boiler unit has a total heating surface of 37,339 sq ft, an air heater surface of 139,500 sq ft, a furnace volume of 24,900 cu ft. It is designed for heat release in the complete furnace of 32,700 Btu per cu ft per hr. Heat release in the cyclone burner itself is 545,000 Btu per cu ft per hr. All furnace wall circuits discharge into and are fed from the 60-in. drum and to insure positive natural circulation in this unit, two 21-in. downcomers lead from each end of the main steam drum, as shown in Fig. 11 and Fig. 8. These downcomers connect with the boiler circulation system as shown.

How Cyclone Burner Works

The cyclone burners for firing crushed coal to this boiler are built and arranged as shown in Figs. 1, 2, 4 and 7. They are cylindrical, with the horizontal axis set 5 deg above the horizontal so that molten slag drains into the secondary furnace from which it discharges continuously.

All air and fuel are admitted to the burners or primary furnaces, and the flame and products of combustion discharge through a conical opening into the secondary furnace, where a reflecting arch directs them down to sweep the molten slag on the secondary furnace floor. The gases then turn and pass up through a slag screen and upward through the secondary furnace and boiler.

As noted above, one of the primary objectives in utilizing this burner is to keep the slag inside the burner in a molten state and to discharge it from the furnace still in a molten state, so that it will not pass into the boiler or coat the furnace walls of the secondary furnace.

This is accomplished by tangential firing in the burner. It is done by introducing a stream of primary air and crushed coal into the burner, causing a cyclonic action in the burner, at the same time adding an independent supply of secondary air along the length of the burner. The two streams mix in the burner, which will be kept coated with molten slag to act as an insulator for the burner walls and to catch and hold the coal particles.

Each cyclone burner is 8 ft inside diameter and 11 ft long with a primary burner at the front end, a secondary longitudinal air port and a throat 42 in. in diameter at the discharge end. The burner is constructed of semi-circular water tubes 1½ in. in diameter, arranged to be connected into headers as shown in Fig. 11, and has natural water circulation.

In addition to primary and secondary air, tertiary air enters at the front of the burner in the same direction but on the opposite side from the primary air. The total combustion air is divided into about 15 per cent primary, 80 per cent secondary and 5 per cent tertiary air. The forced draft air blowers will maintain a pressure of about 14 in. H_2O at the discharge throat of the burner, so the pressure in the secondary furnace will be approximately 11 in. H_2O. These three air streams, entering tangentially to the circular section of the burner, whirl the flame and combustion gases in the burner. The function of the tertiary air is primarily to impart longitudinal motion of the flame through the burner and to complete the combustion of the fines.

The secondary air enters the burner at 20,000 to 30,000 ft per min. After the secondary air enters the furnace its path becomes helical, for it must move toward the end in order to

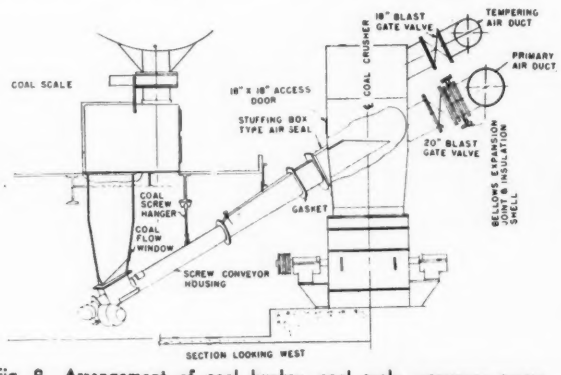


Fig. 9. Arrangement of coal bunker, coal scale, conveyor screw feeder and coal conditioner for supplying coal to Boiler No. 13 cyclone burners. Four scales, two feeders, two conditioners supply two burners. See Fig. 3. Coal supply varied by change of coal feeder speed, to maintain steam pressure

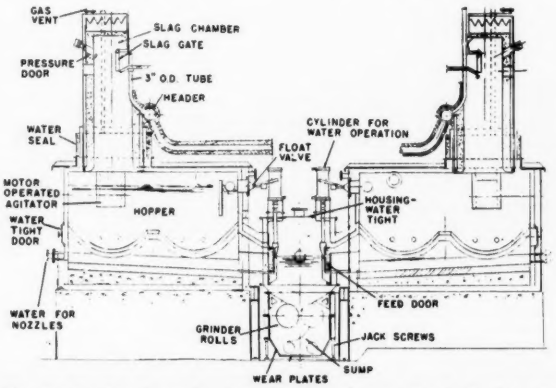


Fig. 10. Section through ash handling equipment for Boiler No. 13 showing how slag flows through slag gate, drops into water in chamber where it breaks up, and flows to center sump, from which it is pumped by ash disposal pumps

discharge through the 42-in. conical discharge opening in the front wall of the secondary furnace. After preliminary combustion of the fuel and primary air mixture, the primary air is blended with the secondary, to complete combustion, slightly beyond the front of the secondary port and continues on through the furnace in a solid stream of gas.

The burners are ignited with either oil or gas, burners for these being provided, Fig. 4. Interlocked gas and air pressure switches will shut off the gas supply upon failure of either pressure.

The 1½-in. diameter cyclone burner tubes are fully studded, spaced on 2¼-in. centers. The secondary furnace floor is of Bailey block construction and the roof of the secondary furnace is of flat stud construction. Side walls of the secondary furnace are 3-in. OD tubes fully studded under the reflecting arch at the primary furnace discharge, and in the main furnace area above the screen. Remainder of the walls are flat-stud construction. A continuous slag-tap opening is located at the secondary furnace floor level about 7 ft from the front wall.

Pressure Furnace and Air Supply

Since the furnace of this unit is designed to operate under pressure and there are no induced draft fans, all combustion air is supplied to the burners by the forced draft blowers, as shown in Figs. 3, 5 and 7. These blowers, supplied by the Joy Mfg. Co., are each designed to deliver 52,500 cfm of air at 77 in. water pressure. Two blowers have sufficient capacity to furnish the necessary air to the boiler, one blower serving as standby. Each unit is driven by an 800-hp Elliott Co. direct-connected motor. The blowers have variable-pitch primary and secondary stage blades and each unit is equipped with two cooling blowers and two lubricating oil pumps.

Inlets to cooling fans are from each side of the building and they are equipped with a traveling, self-cleaning air filter. Starters for cooling blowers are interconnected with starters of the main blower to start at the same time.

Air discharged from each forced-draft blower passes through a motor-operated Heacon damper and check valve to a common plenum chamber and thence to the primary air heater, Fig. 7. The discharge duct from each forced draft blower ahead of the Heacon damper is equipped with an air-operated relief valve. These valves are operated by a diaphragm motor (air-to-open, spring-loaded-to-close). The valves are automatically controlled to prevent air pressure in the plenum chamber from rising above a predetermined limit. These valves may also be operated locally.

Completely Sealed Unit

To permit pressure operation of the furnace, the boiler setting is sealed tightly by welding a casing of 10-gage steel plate directly to the tubes. Where openings are required, for slag discharge, flue to air heater, gas bypass flue, and so on, proper sealing measures are provided. A layer of suitable insulation, 4½ in. thick, is applied on the outside of the steel plate casing. This steel plate casing will be at boiler tube temperature and will expand with the boiler sections. Air jets at inspection doors will prevent combustion gases from being forced out of the furnace by the pressure inside when the doors are opened.

How Coal is Prepared and Fed

Coal for the cyclone burners is taken directly from the existing main overhead coal bunker, of the West Side power station. For proper operation of the cyclone burners, the coal is sized to ¼ in. and less.

Since the pressure at the inlet of the cyclone burner is expected to be about 40 in. H_2O, the coal feeding system must be put under pressure.

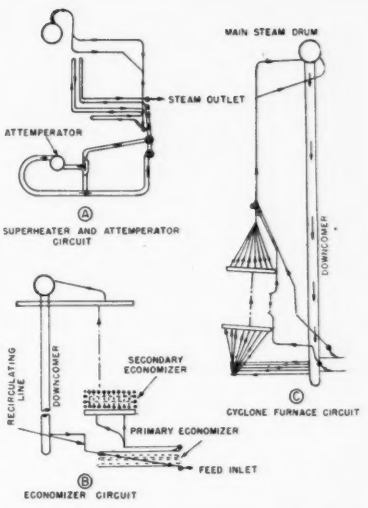


Fig. 11. Flow of water and steam in various portions of the circulating system, Boiler No. 13, A—Flow of steam through superheater and attemperator circuit; B—Flow of water through economizer circuit; C—Flow of water through cyclone furnace circuit

Coal flows from the bunker through Stock Engineering Co. coal scales, of which four are installed. From each pair of coal scales, the coal flows to a B & W conveyor screw feeder, Fig. 9. Two screw feeders lead from the four coal scales and each feeder supplies coal to one of the two coal conditioners, which are standard Pennsylvania crushers with a capacity of 15 tons per hr, each. Each coal conditioner is driven by a Reliance 50 hp constant-speed motor. It crushes coal to 90 per cent through a No. 4 screen or approximately ¼ in.

The coal conditioner is put under pressure by admission of primary air, as shown in Fig. 9, and the mixture of coal and primary air then flows to the cyclone burner.

Seal air blowers furnish sealing air

(Continued on page 131)

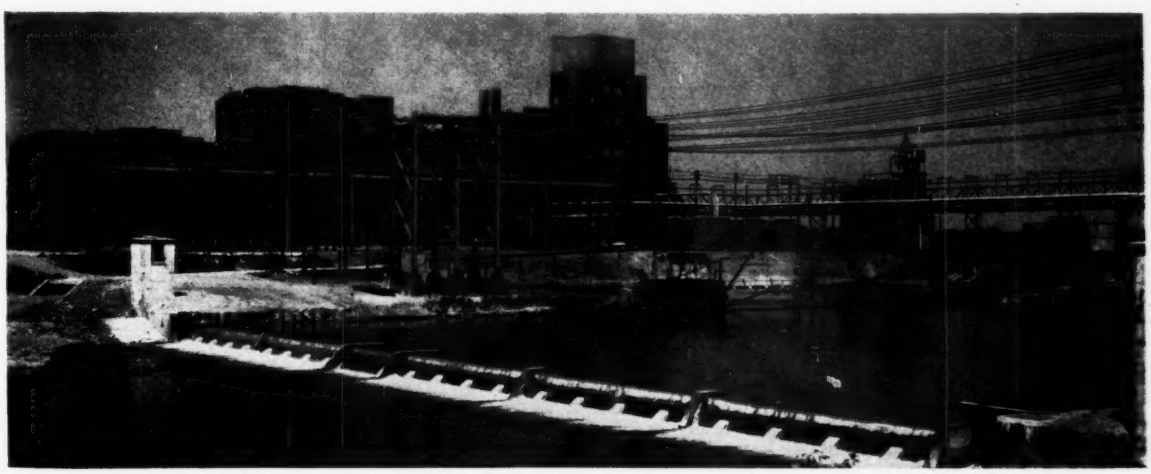


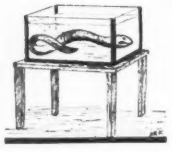
Fig. 12. General view of West Side Power Plant, Dow Chemical Co., Midland, Mich., where Boiler No. 13, fired with crushed coal by two cyclone burners, is installed

What's New in the Electrical Art?

Electric Fishes, Gas Turbines, Human Brains, Microwave Microscopy, Transmission Systems, Five hundred million frame per minute cameras, Ultrafax, Electron Microscopes, Fluorescent Lighting—these, and dozens of other subject, made the Winter Meeting of The American Institute of Electrical Engineers one of the most fascinating ever held. Far more than the, more or less, prosaic papers on ordinary power problems, these new achievements set the future course of electrical engineering

By **ANDREW W. KRAMER** Editor Power Generation

HE WAS ONLY an ugly electric eel. He couldn't see because he was naturally blind; he scowled and was irritable because he was completely out of his natural element; they told shocking stories about him. But he stole the show at the winter meeting of the American Institute of Electrical Engineers in New York last month. Indeed, he made most of the New York newspapers by his antics, which was more than most of the other startling events did at this great technical meeting.



Only a poor, ugly fish

The fish had plenty of first-class competition. There was a camera that would take pictures at the rate of five hundred million frames per second. There were electronic gadgets of a most amazing variety, indeed there were some that could virtually smell. There was enthusiastic, exuberant and extremely vocal Everett Lee, President of the Institute and his famous boss Charles Wilson, President of the General Electric Company. There were electronic computers capable of fantastic performance; electron microscopes were shown that enable one almost to see individual atoms. At the nucleonics session, techniques were described which would easily detect the hundred-millionth part of zenon in air; there was a leak detector capable of detecting a leak amounting to only an ounce in a century. And last, but not least, was Ultrafax, an intelligence transmission system which will easily transmit a million words per minute.

All these things naturally had tremendous appeal. They were new, startling, carried far-reaching implications—they provided inspiration and pride, but none of them caught the fancy of the audiences quite as much as did the scowling electric eel under the ministrations of Dr. Coates at the conference on Wednesday afternoon, February 2. Connected to a wonderful new projection cathode ray oscilloscope provided by the Dumont Corporation, his 400-volt (d-c) impulses, reflected on the screen, were something to think about. For here was an animal—a poor, ugly, blind fish—who could generate electrical energy, chemically, and control it by a process that few electrical engineers in the world know very much about. It made one realize, despite the amazing disclosures at this meeting, how little we actually know about electricity.

The fish's shocking behavior was one thing; it was interesting and provided amusement but over and above the casual interest in the eel's voltage producing abilities lies the deeper understanding of the process which he employs to generate these voltages. These fundamental electrical aspects of the eel's behavior were stressed by Dr. David Nachmanson, assistant professor of neurology at Columbia's College of Physicians and Surgeons, who was one of the principal speakers at this conference on Energy Sources. Dr. Nachmanson, showed that the eel's electrical "wiring" is followed in the nerve structure of all living animals, only their voltage is a great deal lower. He showed how similar electrochemical reactions are employed in transmitting impulses in the nervous system and in the brain cells of man.

Not all the technical papers and informal discussions at the winter convention, however, were on subjects so far removed from the ordinary practicing electrical engineers' domain as electrical fishes. Indeed most of the 125 or more papers and discussions presented at the technical sessions and conferences dealt with the operating, design and maintenance problems of everyday electrical engineering.

At the session on System Engineering, for example, there were papers on the design of steam boilers, on the effect of fluctuating load of steam turbines; the whole problem of the effect of fluctuating electrical load on steam plants, indeed, came in for considerable discussion at this session. Until recent years the practice among operators of large electrical generating systems was to carry relatively constant loads at efficient operating points on newer generators and to carry the load swings on numerous older units. As a result of recent growth, a larger proportion of the total generating capacity is now carried on the newer units and the older units are not always capable of handling swinging loads. A great deal of attention has been given this problem of designing boilers for rapid load swings.

In the marine field, boilers have been designed for extremely rapid load changes and, as was shown in a paper by Dickey and Loughin, both of The Babcock & Wilcox Company, the results of experience with these marine boilers are valuable in designing boilers for stationery service.

One whole session at this meeting was devoted to the use and control of electric fences in rural areas. Death-dealing home-made electric fence controllers on farms and controversy in technical circles that has delayed protective codes in many states were deplored by Professor Charles Dolziel of the University of California. Home-made electric fence controllers, he said, are responsible for the continuing electrocution of both human beings and animals and the use of such controllers should be prohibited by law.

How dry I am

It is impossible in a brief report to even mention all of the many subjects and ideas which were considered at this meeting but the examples mentioned serve to indicate the variety of interests. This year, the meeting was held at the Statler Hotel, formerly the Pennsylvania, in New York, the week of January 31. In previous years, it was always held at the Engineering Building on 39th Street but in recent years the meeting has grown so large that more spacious facilities were necessary. These were amply provided by the Statler. The rooms were large,

comfortable, well ventilated and lighted and the public address systems and projection equipment was of the highest order.

Tenth Anniversary of Fluorescent Lighting

The year 1949 marks the tenth anniversary of the commercial introduction of the fluorescent lamp. This event was marked at the meeting with a conference on fluorescent lighting on Monday afternoon, January 31. This conference was featured by a spectacular demonstration of progress in the art by Willard Brown of the General Electric Co. Mr. Brown described the phenomenal

This worked, SO-o they developed this

growth and acceptance of this type of lighting and demonstrated the various types, sizes and colors of fluorescent lamps now in use. Curiously enough, he pointed out, the "Daylight" lamp, which had been expected to be one of the best sellers, actually accounted for only about 20 per cent of the fluorescent lamps in use. The public prefers the warmer colored "white" types of lamps.

One of the latest developments is a new "white" lamp, designed especially to give warmer tones to human complexions. This new lamp is also more efficient than older ones, producing the same amount of light as the older 100 watt lamp with a consumption of only 85 watts. This improvement has been obtained by the use of krypton in the tube.

Mr. Brown, in discussing the disadvantage in the necessity for ballasts in the use of fluorescent lamps, pointed to the advantage that might be gained by the use of higher frequencies. At 500 cps the ballast size goes down to an almost irreducible minimum, in fact, at such frequencies a capacitor ballast becomes possible. The overall efficiency also is some 20 per cent better. Since it would not be feasible to transmit 500-cycle current over any but the shortest of distances in industrial plants, Mr. Brown described recent, purely stationary, networks that have been developed to generate such frequencies. These networks would be located close to the lamp load centers.

In answer to the frequent question regarding the development of higher-wattage fluorescent lamps, Mr. Brown and his assistant, J. C. Forbes, amusingly lifted the answer to this question from the floor of the stage. This was a 20-ft dummy lamp, some 6 in. in diameter. If a 1000-watt lamp could be produced, Mr. Brown said, it would have to be the size and diameter of this dummy. The inference was obvious. The largest fluorescent lamp sold commercially today is the 100-watt size which is 4 ft long.

Transistor—The Little Giant

Readers of these pages may recall the description of the Transistor in the October 1948 issue. This amazing product of Bell Telephone Lab research formed the subject of two papers at the conference on radio communication systems on Monday afternoon. The transistor is a strange, wonderful, absurdly simple device—nothing that could not have been made 2000 years ago—that undoubtedly is going to replace millions of vacuum tubes throughout the world in the years to come. As small as a paper clip, hardly more complex in its basic design, it is capable of acting as an electric amplifier or as an oscillator. As a matter of fact it can do practically everything a triode can do, yet it has no vacuum, no sealed envelope and requires no heater current. It is instantly usable, that is, it requires no warming-up time, and since there is no heater current its heat dissipation is very low.

A feature of this session was the announcement of the new "coaxial" transistor in a paper by Kock and Wallace both of Bell Telephone Laboratories. The coaxial transistor is a further development of the original form of transistor announced last summer. In experimenting with the transistor it was found that if, with a wedge-shaped germanium crystal, the emitter and collector contacts were placed very close to the apex of the wedge but on opposite sides, transistor action would take place. This experiment proved that the emitter contact could influence the collector even though a thin layer of germanium intervened.

This, logically, led to the design of the coaxial transistor, shown, roughly, at the left. This transistor, it will be seen consists of a tiny wafer of germanium, cupped on both faces, mounted, inside of a cylinder with "cat whisker" contacts on the opposite faces. With this type of construction the contact points are perpendicular to the crystal surface; also, the emitter and collector are separated by an electrostatic shield—the germanium crystal itself.

An amusing feature, in the presentation of the two papers on transistors, were the two transistor gadgets which the authors of the papers demonstrated. These consisted of small battery-operated transistor oscillator and amplifier circuits, all contained in small cases, housing in addition small loud speakers. One of these was fitted with several oscillating circuits each containing different LC ratios and each connected to push buttons on the outside of the case. By pushing these buttons the loud speaker would emit different andio frequency notes. Mr. Shine, who showed this device, demonstrated his musical ability in his rendition of the famous aria "How Dry I Am."

Television—Our New Eye

Television, naturally, formed the basis of many papers and discussion at the winter meeting. Even those who were not commercially or professionally interested in the subject found Dr. Goldmark's (CBS) discussion on brightness and contrast in television of interest, since this was of interest to every owner of a television receiver. Dr. Goldmark showed, by most careful studies, that increase of picture highlight brightness is not the answer to better video images. Contrast range, he indicated, is of much greater importance than mere brilliance. Contrast at moderate brightness is far more important to the eye than brightness applied indiscriminately. Experiments with visual acuity and with contrast rec-

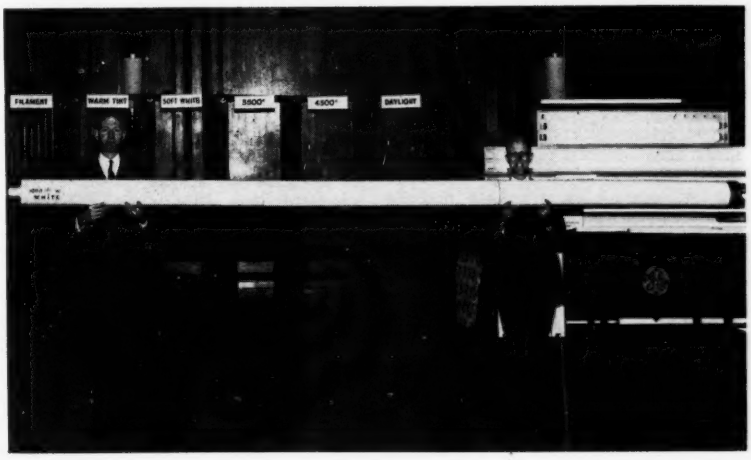
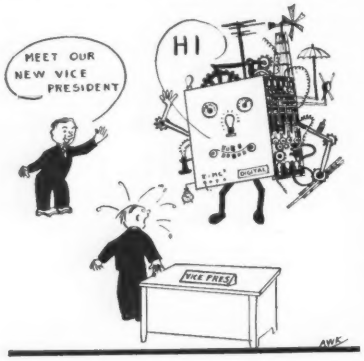


Fig. 4. This is why 1000-watt fluorescent tubes are NOT available. At the 1949 Winter meeting of AIEE in New York, W. C. Brown (right) manager, Engineering Div., Lamp Dept., General Electric Co., Cleveland, said if 1000-watt tubes could be produced, it would have to be the size of a 20-ft dummy he is holding with J. C. Forbes, supervising engineer, N. Y. Lamp Dept., G. E. Largest tube sold commercially today is 100 watts and is 4 ft long.

ognition have shown that both reach their optimum for a given brightness when the surrounding illumination is about the same as the local illuminated area. A surrounding which is too bright or too dim tends to decrease the effectiveness of the visual functions.

An important development in the construction of television tubes was described in a paper by H. P. Steier of RCA. This is the large screen metal kinescope recently perfected. The use of this new metal tube will not only result in improved performance and make possible larger



If computers can be made to make 2nd and 3rd order decisions we could get rid of all our vice presidents

viewing screens but it will reduce manufacturing costs. Many people do not realize that an ordinary television kinescope must be capable of withstanding great atmospheric pressure. As a consequence, in breakage such tubes can be very dangerous. By the use of a metal envelope, this danger is practically eliminated. The new metal kinescope, known as the RCA, 16 AP 4 is made for 3 atmospheres! It is capable of withstanding a total pressure of 4 tons.

Television has many angles of interest. The one which is of particular interest to the power engineer is the question of total load of television receivers on utility systems. As is well known, in recent years several power systems have introduced a television demand charge in their rate structure. The necessity and fairness of this charge has been the subject of considerable discussion and controversy in recent years and it is for this reason that S. C. Spielman's paper on input power requirements of television receivers received considerable attention. Mr. Spielman, who is with Philco, showed that the power requirements in television receivers varied between 100 and 500 watts with an average probably around 250 watts. Ordinary radio receivers require from 30 to 175 watts. Television, it is obvious cannot match for power consumption such everyday household appliances as electric toasters or electric irons.

The greatest single power requirement in television receivers, Mr. Spielman said, is for magnetic deflection of the electron beam in the horizontal direction. Large amounts of power are required to swing the electron beam horizontally at the rate of 17,700 scans a second. This relatively large amount of power is needed not because of the actual work done on the electron beam, because this actual work is negligible. The energy is used up in the tube and circuit components which are required to generate this very exacting type of variable magnetic field required to retrace the beam in 1/10 of its scan time. Circuits are now in operation in various laboratories and can be expected to appear in commercial receivers that will improve the efficiency of this particular portion of the set markedly.

Thus it appears that, while a number of utilities were somewhat fearful of the television power load, there is no reason for concern. The television receiver constitutes a desirable load, its power factor is good and it will grow. It is estimated that 800,000 television sets are now in use. Since their average power is 250 watts this represents a total load of 200,000 kw. Part of this will, of course, be nullified by a decrease in the number of radio receivers in use, and a slight decrease in the concurrent lighting load. Each television receiver probably represents 200 watts of consumer load. Project this to 10 million television receivers, estimated to be in use in 5 years and a 2 million kw consumer load is indicated. This load, with its good power factor, should be most welcome to an expanding electric power industry.

Computers—Digital and Otherwise

The electronic computer industry is booming. Each year during the last 4 years these electro-mechanical mathematical brains have received increasing attention at the winter meeting and this year they were given a complete session, in addition to receiving attention at other sessions. Professor Weiner has likened the advent of the digital computer to a Second Industrial Revolution. Indeed, as S. N. Alexander of the National Bureau of Standards pointed out, if we can make the electronic computers make 2nd and 3rd order decisions, it can become a great boon to mankind—we could get rid of all the vice presidents.

Computers, as J. W. Forrester of MIT pointed out in his discussion of the scope of electronic digital computers, are more than calculating machines. They are wrongly named; actually they are systems for information processing. That is why, as S. N. Alexander of the Bureau of Standards indicated, the various departments of the U. S. Government are interested in them—the Departmen of Census and the Social Security Bureau.

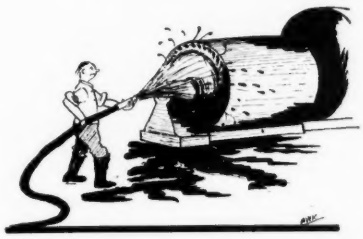
At another session, a symposium on new tools for research, H. H. Aiken of Harvard University stressed the great need for training personnel to operate electronic computers. Unless we do this, we will find that our computers are standing idle. It frequently takes weeks of preparation to code the information for a certain problem, which a computer such as Mark III, now going in at Harvard, can solve in a matter of hours.

The shocking truth about the Eel

As pointed out at the beginning of this report, one of the most interesting sessions at the winter convention was the conference on energy sources, where the electric eel performed so well. This conference

Fig. 6. Charles E. Wilson, president, General Electric Co., congratulates Norris E. Leeds of Philadelphia, winner of 1948 Edison Medal presented to him Feb. 2 at 1949 Winter Meeting of AIEE in New York. Medal awarded "for his contributions to industry through development and production of electrical precision measuring devices and controls."

opened with a most interesting paper on the effects of electricity on the human body by Dr. Kouwenhoven, Dean of the School of Engineering at Johns Hopkins. This is a subject on which Dr. Kouwenhoven has done a great deal of work. If for no other reason, the subject is of interest because in the utility field alone we lose between 70 and 80 men a year from accidental electrocution. Low-voltage a-c, Dr. Kouwenhoven ex-



New idea for cooling electrical machines

plained, is much more dangerous than low voltage d-c, in fact he knew of only one case where man was killed by 120 v d-c. This man used a defective portable lamp while inside a Scotch boiler. A man has been killed on a-c voltages as low as 32, though usually 44 v would be about the lower limit. Much depends upon the condition of the skin. Dry skin may have a resistance of as much as 100,000 ohms. When wet, this may fall to 1000 ohms.

Strangely enough, the resistance of the skin changes when a person goes to sleep. When you go to sleep the resistance of your skin practically doubles. Even in a baby, 4 months old, as soon as it falls asleep the resistance of its skin goes up. If its sleep is fitful it varies, up and down. This action, indeed, has been used to expose individuals who feign sleep.

Dr. Kouwenhoven described the use of countershock technique in overcoming ventricular fibrilation, which he said is also induced by anesthesia. This is a condition, usually brought on by electric shock, where the heart foregoes its usual rhythmic action and its action becomes spasmodic. By sending currents of as much as two amperes directly through the heart, the fibrilating condition can be stopped. Several most interesting cases of this technique were described.

The remaining portion of the program following Dr. Kouwenhoven's address was devoted to the generation of nerve electricity and demonstration of its production in the electric eel. The first paper on the subject of Electric Fishes was given by Dr. C. W. Coates, Curator and Aquarist of the N. Y. Aquarium. Dr. Coates had one eel in a glass tank, so the audience could observe him. These eels, from the South American rivers, have an attack power as high as 600 volts. They have poor eyesight but seem to have radar location abilities since they are always able to locate their objectives promptly. This eel from the fresh waters of South America is the most potent electrically of the half dozen kinds of electric fish found in the fresh and salt waters of the temperate and tropical zones of the world. It unleashes its voltage at the slightest disturbance of the shallow waters in which it dozes. If this is a watering place or ford, horses and cattle often receive shocks and sometimes are killed by the terrific jolt the fish can emit. When excited, the eel will deliver some 300 separate impulses per minute at an average voltage of 370. His current output is relatively low compared to other types of electric fish—it is about 1 ampere. Some of the salt water electric fish generate currents as high as 1000 amperes, but at low voltages.

In a demonstration at the end of the session by Dr. M. V. Brown of the Dept. of Physics of the College of the City of New York, an eel was placed in a wood trough and electrodes were applied along its length. These electrodes were connected to a Dumont projection cathode ray oscilloscope so that the voltage impulses generated by the eel were projected on the screen. As Dr. Coates tapped the eel's scowling mouth there was a sharp increase in the electrical activity. The fish's output is fairly constant, Dr. Coates said, he doesn't get tired and can keep up his generating ability all day.

Of greatest interest, despite the excellent demonstration put on by the fish, was the paper on the Chemical Mechanism of Nerve Electricity by Dr. Nachmanson of the College of Physicians and Surgeons of Columbia. It has long been known that nervous impulses are communicated to and in the brain, electrically. As Dr. Nachmanson disclosed, however, this electrical action is very different from what goes on in a metallic conductor.

In fluid mediums, there is no physical explanation of flow or movement of electrons. From long and continued research it has been found that the nerves are composed of series of chemical cells normally charged electrically. When an impulse is transmitted the cells discharge separately and progressively. Thus the discharge of each cell initiates the action in an adjacent cell. Conduction in the cells depends upon the presence of certain enzymes —cholin-esterase. Removal of this cholin-esterase blocks conduction. The action is extremely complex and not easy to understand from a brief discussion, but it is extremely fundamental and of great importance. Dr. Nachmanson told of certain powerful toxic agents the Germans had developed—agents which destroyed the cholin-esterase and therefore caused death.

Basic Sciences—Brains, Flatworms and Computers

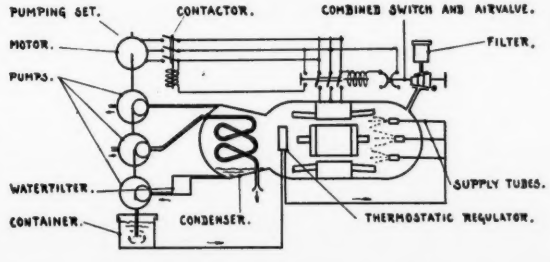
Closely related to Dr. Nachmanson's discussion on the mechanism of nerve electricity was Neurophysiologist Warren McCulloch's extremely learned address on the brain as a computing machine at the session on

The Germans developed this

basic sciences on Monday afternoon. He pointed out that the more the neurologists learn about the human brain, the more it looks like an electrical calculating machine. The brain is made up of neurons (nerve cells) which are nothing more nor less than small electrical relays, each containing its own built in power supply. The cells burn sugar to carbon dioxide and water and the energy thus released is used to keep the outer surfaces of the cells electrically charged with respect to their interiors. The charge amounts to about 0.07 v.

These nerve cells are connected together by slender, wirelike fibers (neurofibrils). Some have only two fibers, others several hundred. Like the cells, the fibers are electrically charged. Normally, a nerve cell is like an electrical relay waiting for a signal to actuate it. When the signal—a pulse of energy from another neuron—arrives, the cell "fires." An electrical disturbance starts at its center and travels outward along all its fibers. When the pulse reaches the end of the fiber

(Continued on page 133)



Th. de Koning's cooling scheme in principle. The condensed vapor collects in the lower half of the condenser and passes through a cleaning filter in the refillable water container at atmospheric pressure

ATOMICS

A New Section added to POWER GENERATION to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

Ten Years of Atomic Energy Development

This article is, essentially, a digest of the Fifth Semiannual Report of the U. S. Atomic Energy Commission issued in January of this year. Since the report comprises some 200 pages, this digest, which is concerned primarily with the technical work of the Commission and its contractors, should be of interest to those in the engineering profession who want the facts about atomic energy developments but have little time to read

By **ANDREW W. KRAMER** Editor, Power Generation

ATOMIC ENERGY DEVELOPMENT in the United States is now ten years old. It was in the last week of January 1939 that the phenomenon of nuclear fission was first confirmed in the United States. In this decade, a whole new body of knowledge has been built up. Frontiers of science have been pushed far ahead; new techniques have been developed and put to use. Atomic energy has been used as a weapon of war; indeed, it helped bring about a quick end to the greatest war that ever raged this planet. But atomic energy also holds promise of great benefits to mankind and today, men are dilligently seeking the means of developing the new knowledge and of controlling this new force in order to realize those benefits. All over the land, in great laboratories, in our universities, in our industrial establishments and in our government bureaus, men are uncovering new aspects of this greatest of all forces. Never, in all the world's history has so much been accomplished in so little time.

Two years ago, the United States Atomic Energy Commission was established under the Atomic Energy Act of 1946, which sets forth the broad policies and objectives of the national atomic energy program. In its Fifth Semiannual Report, issued last month, the Commission recounts its work and progress during the two years of its existence. This report makes interesting reading and it would be well if all thinking people would read this report and consider, seriously, its implications, if for no other reason than as tax payers.

During the ten years since atomic fission was discovered, the American people have invested more than $3,000,000,000 in atomic energy, starting with the first allocation of $6000 in 1940 and including $342,-000,000 expended by the Commission in 1947 and about $525,000,000 in 1948. As pointed out by the Commission in the report, the accounting to the American people for the expenditure of such sums, under restrictions which preclude normally free and open analysis, places the Commission in a position not fully consistent with the traditional methods of public accountability and management.

This report, and a subsequent special report on Reactor Development which the Commission will submit to the Congress in the near future constitute an attempt to provide information on plants and on operations essential for an understanding of the purposes and results of the Nation's heavy expenditures for atomic energy development, and the problems and difficulties encountered in the program.

During the two years that the Atomic Energy Commission has directed development the trouble spots which threatened continuity of production of fissionable materials, the report indicates, have been largely eliminated. The weapons situation has been greatly improved. Important additions have been made to scientific and technical knowledge and a program of development of nuclear reactors aimed at the possible production of power and the breeding of new fissionable materials has been formulated and is being vigorously prosecuted.

Production of Fissionable Materials of Key Importance

The production of fissionable materials, U-235 and plutonium, is of key importance in the U. S. atomic energy program. It is a huge and complex undertaking, beginning with the search for uranium ores and ending with uranium 235 and plutonium. It is at the same time one of the largest integrated industrial operations in the world, and the newest. Eight years ago many of the mines from which uranium ore is dug were not even staked out, and none of the gigantic plants where production of U-235 and plutonium takes place had been designed or even imagined.

The diagram, Fig. 1, shows the successive steps in the production and use of U-235 and Pu-239. The procurement of raw materials, their refinement into feed material for the main plant units at Hanford and Oak

Ridge, the creation or extraction from them of fissionable materials, and the utilization of the fissionable materials into weapons and nuclear reactors.

Uranium, the raw material of atomic energy, is not a rare metal; it is distributed widely throughout the earth's crust, in the proportion, roughly, of six parts to every million. But few ore deposits rich in uranium have been found. Uranium is always associated with radium. Following the discovery of the rich uranium-radium deposits in the Belgian Congo about 1920, there was little interest in the search for uranium until its use in atomic energy was understood. Since then, uranium has been the object of intensive search in every part of the world. Nearly every country is sponsoring exploration for it. The search is not for high-grade deposits only, but also for low-grade materials containing only a few pounds of uranium per ton. Scientists and mining engineers are developing and improving methods for extracting uranium from low-grade ores—from carnotite ores in the United States, for example; from Swedish oil shales; from South African gold ores. The United States continues to receive most of its uranium from the Belgian Congo and Canada.

Our own country has produced little uranium. Such production as we have had has come from the low-grade carnotite ore of the Colorado Plateau, which has been mined primarily for vanadium, with uranium recovered as a by-product.

The United States is still dependent upon foreign sources of uranium but the Atomic Energy Commission has initiated an extensive exploration program throughout continental U. S. and Alaska. Incentives have been set up for prospectors and mining companies and research is under way to develop and improve methods for processing uranium ores. Recent general reconnaissance has resulted in the finding of two formations of uranium-bearing shale. Major exploration was carried on in the Colorado Plateau region.

The huge and complex plants that produce fissionable materials — the isotope separation plants at Oak Ridge, and the nuclear reactors at Hanford—work on vastly different principles. While each group does at the start of the process require large quantities of extremely pure natural uranium, it has to be fed to the respective processes in very different forms. At Oak Ridge it is fed as a gas (uranium hexafluoride), at Hanford, as a metal. The hexafluoride plants at Oak Ridge were constructed under wartime stress and were not intended for permanent operation. The Commission has under way studies on design of more efficient, less costly hexafluoride plants capable of long-term operation. Even with present equipment production costs have decreased while the output has increased. Taking the cost level for 1946 as 100, it was 97 for 1947 and 87 for 1948.

The Gaseous Diffusion Plant

The gaseous diffusion plant at Oak Ridge, consists of thousands of diffusion barriers—porous barriers through which uranium hexafluoride gas is continuously cycled, recycled, and finally drawn off when it reaches a certain state of enrichment in the U-235 isotope. This process requires thousands of miles of pipe, thousands of pumps and motors and myriads of intricate electrical and electronic mechanisms for control of the whole complex process. Because the uranium hexafluoride is intensely corrosive, the entire system must be leak proof and corrosion proof. This diffusion plant (K-25) is the largest continuous process plant in the world under a single roof—a 60 acre roof. K-27, a companion process building, is approximately one-fourth as large. The accompanying steam power plant is the largest of its kind ever constructed at one time.

The porous barriers through which the uranium gas is diffused probably are unlike anything ever before

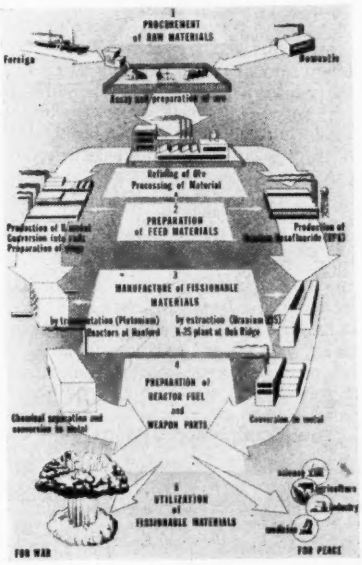


Fig. 1. The production of fissionable materials

devised by man. They must contain *billions* of holes *per square inch,* each a few ten-millionths of an inch in diameter. They must be very thin and therefore very fragile, yet must withstand considerable pressure. They must be supplied in enormous quantities; the total area of barriers used in the plant is measured in square miles. Barrier manufacture since its inception has been a "batch-type" operation; recent developments, however, have pointed the way toward a more efficient process for continuous production of barriers. Efficiency of U-235 production would be greatly increased by this change.

As already explained, uranium hexafluoride is extremely reactive—actually, it eats through glass, hence, it is a most difficult material to handle. Yet in K-25, it must pass through tens of thousands of pumps, valves, and couplings, without leakage. No ordinary pump packing or valve seat can contain it. An entirely new substance was needed. During the war, a corrosion-resistant plastic compound, fluorothene, was developed. Because of the potentialities this plastic offered, during 1947 and 1948 the Commission and contractor have developed new and improved methods of using it at various points in the K-25 process.

Research on Gaseous Diffusion Process

The sum total of improvements that have been effected in the gaseous diffusion plant during the past two years, has increased the production yield by a substantial factor. Improvements immediately in prospect will bring further increase. At the same time, a reduction of 15 per cent in operating expense has been accomplished during a period when costs of both labor and material were steadily increasing. There is continuous investigation into possible improvement of the gaseous diffusion process. Two major design studies were completed in 1948—one for an addition to K-25, the other for an entirely new plant of greatly increased efficiency.

Construction on a large addition to the K-25 plant is expected to start in the summer of this year; this, should be in operation by late 1951.

The proposed new gaseous diffusion plant will be much smaller than K-25. It is expected that the new plant will produce U-235 much more economically than K-25. The Commission is now undertaking economic, material, and other surveys to determine the feasibility of constructing such a plant.

The Hanford, Wash. Plutonium Plant

The Hanford Engineer Works, as constructed during the war for the production of plutonium, consisted of three reactors and the necessary chemical separation plants together with a multitude of supporting facilities including the plant for canning the uranium slugs in aluminum before they are fed into the reactor, and the community of Richland to house the plant operators. The reactors were isolated and widely separated from one another in the Hanford reservation, which com-

prises some 400,000 acres—more than half the area of Rhode Island.

The designers and builders of this plant raced against time with only laboratory demonstrations to guide them. When they started the only plutonium ever produced was such a small amount as to be invisible to the naked eye. The builders of Hanford were successful because they concentrated upon one objective: the production of an atomic bomb. Many assumptions had to be made, and it is a tribute to the skill of those responsible for the design that the reactors, though somewhat deteriorated, are still in operation today.

The deterioration of the reactors resulting from over three years of intensive operation required a major overhaul and reconditioning program at Hanford. At the same time the national interest required an increasing supply of fissionable material.

The Commission's program at Hanford, therefore, shaped itself around three major objectives:

1. Rehabilitating existing equipment and operating it more efficiently to prolong its useful life and raise the rate of output.
2. Building plants to replace existing facilities plus additional plants for greater production capacity.
3. Developing new and more efficient processes and operating techniques.

The past two years have seen marked progress toward all of these goals. Late in 1948, the production rate of the original reactors was greater than any achieved in wartime. New chemical processes that should bring great savings in uranium are now in the pilot-plant stage.

Reactor Maintenance and Repair

In its simplest terms, a plutonium-producing reactor is a pile, or solid mass, of graphite pierced at intervals by tubes that run from one side of the pile to the other. Uranium, in the form of slugs, is fed into these tubes, where nuclear fission transmutes a small portion of it into plutonium. Under the severe conditions of high level operation, serious operating difficulties had developed. During 1948, however, by replacement of parts and changes in operating techniques, progress was made in overcoming these difficulties.

By late 1947, it had become clear that a major repair program was urgent if the reactors were to be kept in operation. Repairs were started before the end of 1947. Production of plutonium could not be interrupted. Therefore, portions of the repair job were scheduled during each period of normal operating shutdown for the insertion and discharge of slugs. By mid-1948, the work was essentially completed and production of plutonium in a given reactor during the latter half of the year compared favorably with the highest wartime rate.

A nuclear reactor cannot be taken apart for repairs. The residual radioactivity that infests all its component parts makes this normal maintenance operation impossible. The Commission's contractors, however, have learned a number of maintenance devices which have already prolonged the usefulness of the reactors. Others will be developed. There can be no certainty about the life of the reactors; sooner or later their failure may cause permanent shut-down.

New reactors, therefore, would be required even to assure the maintenance of the present output. Schedules, however, call for increased production. To provide the additional capacity needed, a reactor construction program was authorized late in 1947 and was brought to peak activity in 1948.

Chemical Separation

After irradiated slugs have been discharged from the reactors, they are chemically treated to extract and purify the plutonium. The chemical plants devised for this purpose are large and of novel design. They are, essentially, long, deep, canyons of concrete (approximately 90,000 cu yd of concrete for each plant) containing processing cells within which the necessary series of chemical operations can be carried on by remote control. The slugs are intensely radioactive; personnel remain behind heavy shields several feet thick and view the process through periscopes. Residues must be very carefully handled. After the plutonium has been extracted, the remaining uranium, contaminated with highly radioactive fission products, is held in storage.

The Commission and its contractors are devoting much research, development, and construction effort to the improvement of these processes. Laboratories, warehouses, shops, railroads, bridges, utilities, fencing, and other security installations, additional storage facilities for radioactive wastes—all have been under construction in 1948, together with the additional housing and other facilities required to serve the residents of a permanent community of over 20,000.

Los Alamos

The center for the development of atomic weapons is the Commission's Los Alamos Scientific Laboratory, operated under a contract with the University of California. Los Alamos is about 35 miles from Santa Fe, N. Mex. The work at Los Alamos includes research on the physical, metallurgical, and nuclear properties of fissionable materials and other materials of interest. The laboratory has a cyclotron, a betatron, a Cockroft-Walton accelerator,[1] and a 2½ million-volt electrostatic accelerator. A 12-million volt electrostatic accelerator, authorized in March 1948 now under construction, will furnish precise data on high energy interactions between atomic nuclei. There are two small research reactors in operation, one employing enriched U-235 and the other, plutonium, which provide neutrons of low and high energies for experimental investigations.

By 1948 the atomic weapons program at Los Alamos had progressed to the point where new designs of weapons had been developed, and full-scale tests were necessary to "prove in" the new designs. Consequently, three atomic weapons were exploded during Operation Sandstone at the Eniwetok Proving Ground in the Pacific in April and May 1948. Unlike the tests at Bikini in 1946, the primary purpose was not to determine the destructive effects of atomic weapons on ships,

[1] See, Recent Developments in High Energy Physics, by Andrew W. Kramer, Power Generation, January, 1948. Page 91.

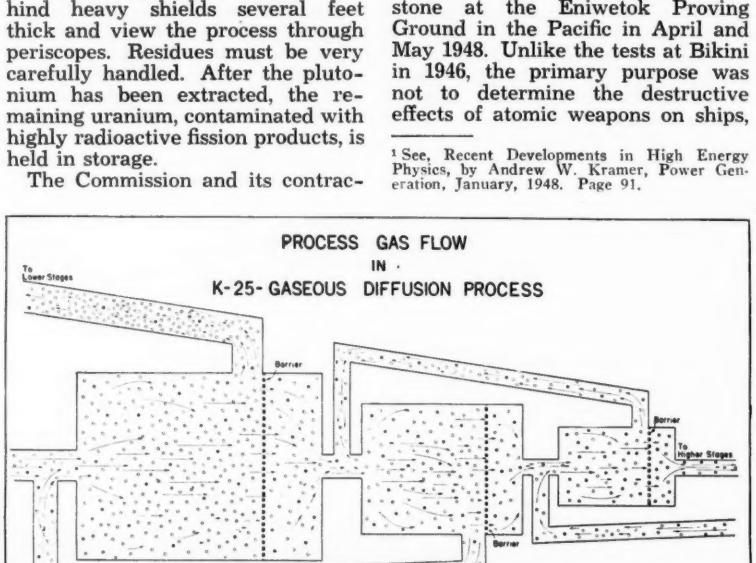


Fig. 2. Process gas flow in K-25 gaseous diffusion process

but (1) to ascertain the energy of explosion of weapons of new design and (2) to measure certain physical phenomena which occur during the explosion. These tests indicated that the position of the U. S. in the field of atomic weapons has substantially improved. A substantial gain in energy release was obtained. Measurements made during the tests also have furnished a much sounder basis for the understanding of atomic explosions, necessary for the further development of atomic weapons. The developments at Los Alamos and the Enewetok test pointed the way towards the production of improved weapons.

Research in the Physical Sciences

Hand in hand with the great production centers at Oak Ridge and Hanford and with the Los Alamos Laboratory the Commission coordinates a Nation-wide research effort, both in its own and in contractors' laboratories. The AEC statutory General Advisory Committee of distinguished American scientists, industrialists, and authorities in other fields has been a mainstay to the Commission in its job of shaping the broad outlines of the work.

The physical research program—the work in nuclear science and its many related fields, such as chemistry, metallurgy, physics, and mathematics—is carried on for the most part at the large AEC laboratories: Argonne National Laboratory, Brookhaven National Laboratory, Oak Ridge National Laboratory, Los Alamos Scientific Laboratory, The Ames Laboratory, the Radiation Laboratory of the University of California and the Laboratories connected with the major production plants, such as Hanford Plutonium Works, the K-25 gaseous diffusion plant, and the Y-12 Laboratory at Oak Ridge. Also, should be mentioned the Knolls Atomic Power Laboratory at Schenectady operated by General Electric. Other centers of research—institutional and industrial—which during 1948 worked on one or more aspects of the national atomic energy physical research program include the National Bureau of Standards, Columbia University, the University of Wisconsin, The Batelle Memorial Institute, the Massachusetts Institute of Technology, the Carnegie Institute of Technology, the Illinois Institute of technology, the Sylvania Electric Co., and the Institute for Advanced Study at Princeton, N. J.

Today's nuclear science and the atomic energy industry, which is growing out of this science, rest upon the fundamental experiments and deductions of early 20th century physicists. For further advance in the pure sciences, which must precede industrial application, it is necessary in these postwar years to keep a large and growing crew of physicists and chemists experimenting, gathering more data, and reflecting on facts observed and recorded in order to secure new understanding of nuclear forces.

Why is it that the Government today assumes such a prominent part in providing the facilities for physical research? The men of the first four decades of the 20th century whose genius made possible the progress of the 1940's did not do their work in Government laboratories. The reason for such large-scale Government aid is that the gathering of the data on the problems before the nuclear physicists and chemists of today requires the work of men in teams of large size and the use of very expensive equipment. To get further into the mysteries of nuclear structure and nuclear forces, the physicist requires not, as in the 1930's laboratory equipment in $10,000 lots but single machines of great cost, machines such as the multibillion volt particle accelerators the AEC is building at the Radiation Laboratory of the University of California which will cost 9 million dollars and the one at Brookhaven which will cost $3,475,000—machines such as the nuclear reactors nearly finished at Brookhaven, costing $21,600,000.

These facilities and their operating groups are at the disposal of university and industrial scientists. Research work done on two-thirds of the forty-odd particle accelerators in the U. S. is financed in whole or in part by the Commission.

The reason for this widespread and costly scientific fact-hunt basically is that our understanding of the atomic nucleus is today all too inadequate. Though we have learned how to obtain energy in quantity from the nucleus of the atom of uranium and plutonium, we do not know the origin of the forces which hold the atomic nucleus together and hence govern the release of energy. Scientists today can offer no completely satisfactory explanation of most of the properties they have found the nuclei to possess—such properties as the spin of the nuclei, or the strength of the magnetism that atomic nuclei have been shown to have.

New and better instruments are an indispensable key to progress in atomic and nuclear research. The nuclear scientist cannot directly observe what takes place in an atom or in its nucleus. From hundreds and thousands of individual clues, they must piece together a solution to the mystery of what goes on in the nucleus. Since the forces in the nucleus are enormous, power machines are required for their study.

For the past two years and more, for example, the University of California specialists at Berkeley, have been at work on a new super-accelerator (PG-June '48, p 66) a proton synchrotron of 110-foot diameter and a 6-*billion*-electron-volt output, by far the most powerful "atom smasher" ever planned. By early 1948, their plans had become firm enough, and promising enough, so that the Commission could take the step of authorizing the development of this machine. It will cost some $9,000,000 and be 4 or 5 years in the building. It is so entirely unprecedented that its builders will first have to make and operate a quarter-scale model to help solve the problems and locate the "bugs" in the design. The Berkeley proton synchroton will be some 18 times as powerful as the 184-in. synchrocyclotron (PG-Jan. '48, p 91) the present greatest machine. It will attack the atomic nucleus with energies so far beyond today's range that even its designers are unable to predict the nature of the facts it will uncover. More than anything else, this machine, explains why the Government supports nuclear research; no private agency could finance such machines.

Biology and Medicine

Over many decades during which physicians have used X-rays and radium for the treatment of disease, they have become familiar with the harmful effects of overdoses of radiation. Biologists have assisted by studying how radiations affect plants and animals, bio-physicists by studying how they could be measured and controlled. By the time that atomic energy was developed, therefore, science was already familiar with the biological effects of most types of radiations.

What was new to the biologist and the physician in the development of atomic energy was the massive quantity of radioactive materials created and their greater potentialities for both good and ill. The Atomic Energy Commission has the obligation to investigate these potentialities and to encourage and assist others to do so.

The Commission's program of investigation in the life sciences falls naturally into three distinct but closely overlapping fields of effort: *biology, medicine, and biophysics.*

In the field of biology, the Commission is supporting and lending direction to a comprehensive investigational program in its various laboratories and in many private, State and Federal research organizations. The research deals with the broad subject of the effects of radiation on plant and animal life and ranges from the long-time effects of low-level radiation to the effects of high-intensity levels that produce marked injury and death. A major portion of the biology program is concerned with studies in genetics. It has long

(Continued on page 135)

The PRACTICAL ENGINEER

DEVOTED TO PLANT OPERATION and MAINTENANCE

A. W. KRAMER, EDITOR

How To Cut Good Threads By Hand

Cutting threads by hand is not difficult but to do it properly requires knowledge of basic factors. In this article Thomas Trail gives detailed instructions for cutting threads and provides standard tables for various types

By THOMAS TRAIL

THREAD CUTTING is one of the most frequently handled metal-working jobs in the shop. Yet often this type of work is attempted without a thorough knowledge of its basic fundamentals, and the result is an unsatisfactory threading job. But thread cutting is not at all difficult, and if the simple suggestions contained herein are followed, the resultant threads will be of professional quality.

In order to produce good tapped threads it is necessary to have the correct size of drill, properly sharpened; and the threading tap must not be dull or chipped. It is important also to employ a cutting compound or lubricant. This will lubricate the chips and aid in their clearance, cool the drill and the work, and greatly improve the drill's cutting qualities. The same functions will be performed for the tap or die in threading.

In threading rods, it is essential that the threading dies be sharp, free from chipped edges, and properly adjusted to cut the correct depth of thread. The rod being threaded should be smooth, clean and of correct diameter.

When tapping threads, in order to produce threads having sufficient clearance to accommodate both American National and 60 deg Vee threads, it is customary to use a drill size that will leave enough metal to produce 75 per cent depth of threads. This is shown in Fig. 1. This figure also gives the terms relating to threads.

Table I lists the correct size drills to use when tapping American National Coarse Threads. Table II gives this information for American National Fine Threads; Table III, for American National Special (Fractional) Threads, and Table IV for American National Special (Machine Screw) Threads. The American National Screw Thread System was authorized by Congress in 1928, and has been approved by Congress, the Secretary of War, and the Secretary of the Navy. This system is now generally used by all shops in the United States. The American National Coarse Threads supersede the former A.S.M.E. Regular Threads for sizes 1 to 12, and the U.S. Standard Threads for sizes ¼ inch and larger. The American National Fine Threads replace the former A.S.M.E. Special Threads for sizes 0 to 12, and the S.A.E. Standard Threads for sizes ¼ in. and larger.

In Table V are given the drill sizes for tapping American Standard Pipe Threads. These drill sizes permit a full thread to be tapped.

Table VI gives the drill sizes for tapping 75 per cent depth of thread in the International Standard (Metric) Thread sizes.

As has already been explained, a drill must be properly sharpened in order to cut a correct sized hole for thread tapping. This means that the two cutting edges of the drill point must be ground identical both in length and angle, and the metal behind each cutting edge must be ground away on a suitable angle to provide clearance for the cutting edge. This is illustrated in Fig. 2.

The correct speed for drilling metal depends on the size and type of drill and the kind of metal being drilled. The smaller the drill diameter the faster the drill may be run. And the harder or tougher the metal the slower the drill should be run. The speed of very small drills may vary from 2000 to 25,000 rpm, depending on the kind of metal being drilled. Drills as large as 1 in. in diameter should be operated at speeds from 100 to 1500 rpm, on the same basis. These speeds refer to

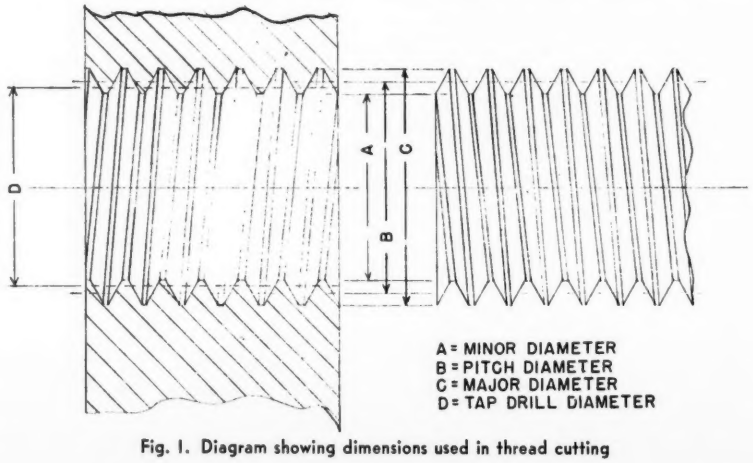


Fig. 1. Diagram showing dimensions used in thread cutting

Table I. American National Coarse Threads

SIZE OF THREAD	THREADS PER INCH	MAJOR DIA. INCHES	MINOR DIA. INCHES	TAP DRILL FOR 75 % THREAD	DECIMAL SIZE OF TAP DRILL
1	64	.0730	.0527	55	.0995
2	56	.0860	.0628	50	.0700
3	48	.0990	.0719	47	.0785
4	40	.1120	.0795	43	.0890
5(1/8)	40	.1250	.0925	38	.1015
6	32	.1380	.0974	36	.1065
8	32	.1640	.1234	29	.1360
10	24	.1900	.1359	25	.1495
12	24	.2160	.1619	16	.1770
1/4"	20	.2500	.1850	7	.2010
5/16"	18	.3125	.2403	F	.2570
3/8"	16	.3750	.2938	5/16"	.3125
7/16"	14	.4375	.3447	U	.3680
1/2"	13	.5000	.4001	27/64"	.4219
9/16"	12	.5625	.4542	31/64"	.4844
5/8"	11	.6250	.5069	17/32"	.5312
3/4"	10	.7500	.6201	21/32"	.6562
7/8"	9	.8750	.7301	49/64"	.7656
1"	8	1.0000	.8376	7/8"	.8750
1-1/8"	7	1.1250	.9594	63/64"	.9844

Table II. American National Fine Threads

SIZE OF THREAD	THREADS PER INCH	MAJOR DIA. INCHES	MINOR DIA. INCHES	TAP DRILL FOR 75% THREAD	DECIMAL SIZE OF TAP DRILL
0	80	.0600	.0458	3/64"	.0469
1	72	.0730	.0550	55	.0525
2	64	.0860	.0657	50	.0700
3	56	.0990	.0758	45	.0820
4	48	.1120	.0849	42	.0935
5(1/8)	44	.1250	.0955	37	.1040
6	40	.1380	.1055	33	.1130
8	36	.1640	.1279	29	.1360
10	32	.1900	.1494	21	.1590
12	28	.2160	.1696	14	.1820
1/4"	28	.2500	.2036	3	.2130
5/16"	24	.3125	.2584	I	.2720
3/8"	24	.3750	.3209	Q	.3320
7/16"	20	.4375	.3726	25/64"	.3906
1/2"	20	.5000	.4351	29/64"	.4531
9/16"	18	.5625	.4969	33/64"	.5156
5/8"	18	.6250	.5528	37/64"	.5781
3/4"	16	.7500	.6688	11/16"	.6875
7/8"	14	.8750	.7822	13/16"	.8125
1"	14	1.0000	.9072	15/16"	.9375

Table III. American National Special Threads

SIZE OF THREAD	THREADS PER INCH	MAJOR DIA. INCHES	MINOR DIA. INCHES	TAP DRILL FOR 75 % THREAD	DECIMAL SIZE OF TAP DRILL
1/16"	64	.0625	.0422	3/64"	.0469
5/64"	60	.0781	.0565	1/16"	.0625
3/32"	48	.0938	.0667	49	.0730
7/64"	48	.1094	.0825	43	.0890
1/8"	32	.1250	.0844	3/32"	.0937
9/64"	40	.1406	.1081	32	.1150
5/32"	32	.1563	.1157	1/8"	.1250
5/32"	36	.1563	.1202	30	.1285
11/64"	32	.1719	.1313	9/64"	.1406
3/16"	24	.1875	.1334	26	.1470
3/16"	32	.1875	.1469	22	.1570
13/64"	24	.2031	.1490	20	.1610
7/32"	24	.2188	.1646	16	.1770
7/32"	32	.2188	.1782	12	.1890
15/64"	24	.2344	.1806	10	.1935
1/4"	24	.2500	.1959	4	.2090
1/4"	27	.2500	.2019	3	.2130
1/4"	32	.2500	.2094	7/32"	.2187
5/16"	20	.3125	.2476	17/64"	.2656
5/16"	27	.3125	.2644	J	.2770
5/16"	32	.3125	.2719	9/32"	.2812
5/8"	20	.3750	.3100	21/64"	.3281
5/8"	27	.3750	.3269	R	.3390
7/16"	24	.4375	.3854	X	.3970
7/16"	27	.4375	.3894	Y	.4040
1/2"	12	.5000	.3918	27/64"	.4219
1/2"	16	.5000	.4594	7/16"	.4375
1/2"	28	.5000	.4459	29/64"	.4531
1/2"	27	.5000	.4519	15/32"	.4687
9/16"	16	.5625	.5219	1/2"	.5000
9/16"	27	.5625	.5144	17/32"	.5312
5/8"	12	.6250	.5168	55/64"	.5469
5/8"	16	.6250	.5844	9/16"	.5625
5/8"	27	.6250	.5769	19/32"	.5937
11/16"	11	.6875	.5694	19/32"	.5937
11/16"	12	.6875	.6334	39/64"	.6094
11/16"	16	.6875	.6065	5/8"	.6250
3/4"	12	.7500	.6418	43/64"	.6719
3/4"	27	.7500	.7019	23/32"	.7187
15/16"	10	.8125	.6826	23/32"	.7187
15/16"	12	.8125	.7584	47/64"	.7344
15/16"	16	.8125	.7719	3/4"	.7500
7/8"	12	.8750	.7668	51/64"	.7969
7/8"	16	.8750	.8344	13/16"	.8125
7/8"	18	.8750	.8028	53/64"	.8281
7/8"	27	.8750	.8269	27/32"	.8437
15/16"	9	.9375	.7952	55/64"	.8281
15/16"	12	.9375	.8894	55/64"	.8594

Table III (continued). American National Special Threads

SIZE OF THREAD	THREADS PER INCH	MAJOR DIA. INCHES	MINOR DIA. INCHES	TAP DRILL FOR 75% THREAD	DECIMAL SIZE OF TAP DRILL
15/16"	16	.9375	.8969	7/8"	.8750
1"	12	1.0000	.8918	59/64"	.9219
1"	16	1.0000	.9594	15/16"	.9375
1"	27	1.0000	.9519	31/32"	.9687

Table IV. American National Special (Machine screw) Threads

SIZE OF THREAD	THREADS PER INCH	MAJOR DIA. INCHES	MINOR DIA. INCHES	TAP DRILL FOR 75% THREAD	DECIMAL SIZE OF TAP DRILL
1	56	.0730	.0498	54	.0550
4	32	.1120	.0714	45	.0820
4	36	.1120	.0799	44	.0860
5(1/8)	36	.1250	.0889	40	.0980
6	36	.1380	.1019	34	.1110
7	30	.1510	.1077	31	.1200
7	36	.1510	.1149	1/8"	.1250
8	30	.1640	.1207	30	.1285
8	40	.1640	.1315	28	.1405
9	24	.1770	.1229	29	.1360
9	30	.1770	.1357	27	.1440
9	32	.1770	.1364	26	.1470
10	28	.1900	.1456	25	.1540
10	30	.1900	.1467	22	.1570
12	32	.2160	.1754	15	.1850
14	20	.2420	.1770	10	.1955
14	24	.2420	.1879	7	.2010

Table V. American Standard Straight Pipe Threads

NOMINAL PIPE SIZE	THREADS PER INCH	MAJOR DIA. INCHES	MINOR DIA. INCHES	TAP DRILL FOR FULL THREAD	DECIMAL SIZE OF TAP DRILL
1/8"	27	.4044	.3451	11/32"	.3437
1/4"	18	.5343	.4435	7/16"	.4375
3/8"	18	.6714	.5826	37/64"	.5781
1/2"	14	.8556	.7215	23/32"	.7187
3/4"	14	1.0460	.9518	59/64"	.9219
1"	11-1/2	1.3082	1.1690	1- 5/32"	1.1562
1-1/4"	11-1/2	1.6630	1.5138	1- 1/2"	1.5000
1-1/2"	11-1/2	1.8919	1.7527	1-47/64"	1.7344
2"	11-1/2	2.3668	2.2267	2- 7/32"	2.2187
2-1/2"	8	2.8622	2.6622	2- 5/8"	2.6250
3"	8	3.4885	3.2885	3- 1/4"	3.2500
3-1/2"	8	3.9888	3.7888	3- 3/4"	3.7500
4"	8	4.4871	4.2871	4- 1/4"	4.2500

Table VI. International Standard (Metric) Threads

MAJOR DIA. m/m	PITCH m/m	MINOR DIA. m/m	TAP DRILL FOR 75% THREAD	DECIMAL SIZE OF TAP DRILL
2.0	.40	1.48	1/16"	.0625
2.3	.40	1.78	48	.0760
2.6	.45	2.02	45	.0820
3.0	.50	2.35	40	.0980
3.5	.60	2.72	33	.1130
4.0	.70	3.09	30	.1285
4.5	.75	3.53	26	.1470
5.0	.80	3.96	19	.1660
5.5	.90	4.33	14	.1820
6.0	1.00	4.70	9	.1960
7.0	1.00	5.70	15/64"	.2344
8.0	1.25	6.38	H	.2660
9.0	1.25	7.38	5/16"	.3125
10.0	1.50	8.05	R	.3390
11.0	1.50	9.05	V	.3770
12.0	1.75	9.73	Z	.4130
14.0	1.25	12.38	33/64"	.5156
14.0	2.00	11.40	15/32"	.4687
16.0	2.00	13.40	53/64"	.5469
18.0	1.50	16.05	41/64"	.6406
18.0	2.50	14.75	39/64"	.6094
20.0	2.50	16.75	11/16"	.6875
22.0	2.50	18.75	49/64"	.7656
24.0	3.00	20.10	53/64"	.8281
27.0	3.00	23.10	15/16"	.9375

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high-speed steel drills. When using carbon steel drills these speeds should be reduced 50 to 60 per cent.

The use of a cutting compound is not necessary when drilling or tapping cast iron or brass, though for the latter sometimes cutting compound or kerosene is employed. For steel, malleable iron, brass, copper, and aluminum and alluminum alloys, soluble oil may be used. Soluble oil is oil that can be diluted with water to provide the proper consistency for the type of work being done. Cutting compounds may be purchased in stores selling machinist's tools and supplies.

When the correct sized hole has been drilled, it is then ready for tapping. Taps are sold in two ways, in sets of three and singly. The sets contain a taper tap, plug tap and bottomer tap. The taper tap is tapered over at least half its length. This tap is used first, and the long taper permits the teeth to cut the metal gradually. The plug tap is used next. This tap is tapered on the starting end only, the bulk of the threads being arranged to cut full depth. The bottomer tap is provided with full depth thread over its entire length and is employed in tapping threads to the bottom of a hole.

If possible, it is well to have a set of three taps for each thread size you are likely to wish to tap. But if economy is an important consideration, and you have little if any need for a bottomer tap, the taper and plug taps only need be purchased. If necessary, a satisfactory thread may be tapped by using only the plug tap. When this method is followed, greater care is necessary to avoid tap breakage.

The tap should be clamped firmly in a suitable holder and started into the drilled hole carefully, so as to follow the direction of the hole and produce a true and accurate thread. Care must be exercised to prevent a bending strain being imposed on the tap, as the hard, brittle metal will break very easily, especially in the smaller diameters. Whenever the tap becomes tight, do not apply extra pressure to turn it, as this may twist it in half. Instead, back the tap out of the hole a thread or two and try again. If it still refuses to cut freely, back it all the way out and remove any metal chips from the tap and hole before continuing the threading operation.

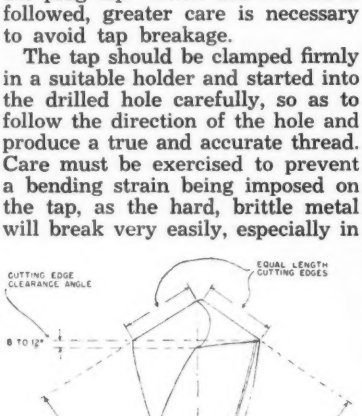

Fig. 2. Details of properly shaped drill point

In tapping blind holes (holes that have a bottom and do not go through the metal) it is necessary to frequently remove the tap from the hole and clear both the tap and the hole of chips. Never attempt to force a tap to cut, because even though you may not break the tap, you may tear or otherwise damage the threads.

If a tap breaks off and cannot be removed from the hole, it is usually advisable to discard the piece of work. But if this is not feasible, it is sometimes possible to heat the piece of tap sufficiently to draw the temper. A very narrow torch flame should be employed for this purpose. When the piece has cooled enough it may be drilled out, if the drilling is done very carefully.

The use of dies for threading rods is similar to tap threading. If the die becomes tight or there is evidence that the chips are jamming, carefully back the die off a few turns to release the chips, otherwise the chips may tear the finished threads.

Before starting a die on a rod, bevel the end of the rod slightly on a grinding wheel, so that the tap will start easier. Be sure the die is free of chips and tightened in the stock. Split type round dies are provided with an adjustment means. This may be a screw in the die itself or in the die stock. To set the depth of cut, thread the die onto a bolt of the proper size and thread, and then tighten the adjusting screw so that there is a slight amount of friction when the die is backed off the thread.

Removable dies, fitted into round collets, are adjusted in a similar manner. Be sure no chips are under or behind the dies when making this adjustment.

In backing the die stock from the newly cut threads, be careful not to strike the end of the threaded rod with the hand, as it is usually quite sharp.

It is always best to thread a sample rod first in order to be sure of the setting of the dies. After a nut has been tried on the new threads, the die setting may be altered if the threads are not a satisfactory fit.

When necessary to cut off a portion of a threaded rod or bolt, always place a nut on the threads behind the piece to be removed. After the cut has been made, round the end on a grinding wheel and then straighten the threads with a slim triangular file. The removal of the nut will then smooth any remaining roughness in the threads.

Occupational Diseases of the Skin in the Electrical Industry

By DR. W. SCHWEISHEIMER

INDUSTRIAL SKIN TROUBLE (dermatitis) occurs more frequently than any other form of occupational disease. Recent statistics have shown that approximately 65 to 70 per cent of all occupational diseases are skin infections.

This is of considerable economic significance. Estimates by leading authorities indicate that the average loss of a workman's time due to occupational diseases of the skin is ten weeks annually with a compensation cost of $150 and a medical cost of $100.

Electrical Insulation Materials as a Source of Trouble

Some of the compounds used in the manufacture of electrical insulation are causes of occupational dermatitis. Electric cables are frequently impregnated with jute, in turn impregnated with hydro-carbons mixed with fatty materials. Often the cable is enclosed in a sheath of lead, and this may be covered with cordage, asphalt, steel ribbon, or water-resisting materials of some other type. L. Schwartz, Tulipan, and Peck have compiled the following list of electrical insulators variously reported as having caused dermatitis.

Just what is Dermatitis? In general any skin eruption the cause of which is known, is called dermatitis. The characteristic signs are reddening, vesicles, or pustules and itching. Pain is not frequent, but the itching may be unpleasant enough to interfere with sleep. Acne is an inflammatory condition of the sebaceous glands of the skin accompanied by comedones, papules, pustules etc. It appears chiefly on the face. Treatment of both conditions often requires great patience. There are literally hundreds of prescriptions for lotions, pastes, and ointments for the treatment of these disorders. Most important in all occupational

Electrical Insulators Causing Dermatitis

CHEMICAL	TYPE OF LESION	USED IN OCCUPATIONS
Rubber	Dermatitis	Wire insulation, Wire stripping
Coal tar pitch	Acne etc.	Wire insulation, Wire stripping, Condensor Mfg.
Asphalt	Acne etc.	Vire Insul., Condensor Mfg.
Vinyl resins	Dermatitis	Vire Insul., Condensor Mfg.
Solid chloronaphthalenes and Sol. chlorodephenyls	Acne	Vire Insul., Condensor Mfg. Wire Strippers
Chlordephenyls	Acne	Same
Vinyl carbazole	Dermatitis	Condenser Mfg.
Phenol Formaldehyde Resin Varnish	Dermatitis	Condenser Mfg.
Asbestos	Warts	Wire Insulation
Dyed Paper	Dermatitis	Cable Splicers

skin diseases is the avoidance of the irritating cause; in many cases this is the only treatment needed. The skin trouble disappears when the source of irritation is removed. In other cases extensive treatment may be necessary even though the source of irritation is removed.

Skin and Dust

Workmen in the electrical industry are subject to skin diseases from exposure to various kinds of dust from the chemical mixtures. Schwartz and Tulipan mention especially the dust of copper, brass and lead produced in various shaping and polishing operations during manufacture. Fumes and spray or mist from nitric acid used in cleaning also may cause trouble as will mercury fumes from solvents in the manufacture of electrodes. The effects of humidity and heat and burns from electric current also can cause skin trouble. Dermatitis has been reported as a consequence of contact with sulphuric acid and oil on copper wire. Among linemen dermatitis from the use of rubber gloves has also been reported in some cases.

Some workers are sensitive (allergic) to particular types of materials to which the majority of workers are not allergic. Modern methods of examination permit one to discover in advance whether or not a worker is sensitive to materials he has to work with. This is done by the skin or patch test. These skin tests are becoming more important every day in industrial practice.

To carry out a patch test, a piece of cotton or gauze is dipped in a watery solution of the suspected material, or a small part of the suspected material itself is used. This is applied to a clear spot on the arm or back. The dressing may be protected by a piece of cellophane, and held by two strips of adhesive tape. The patch test is removed at the end of 48 hours, or sooner in some cases, if inflammation of the skin results.

A positive test is indicated by redness or vesiculation or both at the point of the contact of skin and suspected material. The effect may be immediate or it may be delayed. The redness may be accompanied by itching and the formation of wheals. Frequently it is rather difficult to discover the offending material; in such cases there is nothing to be done but to carry out a patch test with every single ingredient of the suspected material, that may take considerable time and patience.

Electrical Burns

Working with and around electrical conductors causes occupational burns from short circuits, contact with live wires, or charged electrical apparatus. Electrical burns bear little resemblance to burns caused by other forms of heat, and they need particular treatment. The wounds from electrical burns are painless, dry, aseptic (free from germs) and their appearance is characterized by circles, straight lines, and tubular forms. The surrounding skin surface is usually grayish, hard and the hairs nearby are not damaged. At first sight these burns often seem trivial and superficial, but within a few days they may become serious. The arcing of the electric current generates tremendous heat at the point of contact which renders the wound dry and sterile, that is germ-free. The degree of injury depends upon the voltage, amperage, length of exposure, size of the point of contact and the resistance of the skin at the time of contact. The point of entrance and exit of the current generally show the greatest amount of injury. It is commonly believed that more severe burns are caused by alternating current than by direct current. But

PRACTICAL ENGINEER SECTION

"Jones—Get me a copy of the original specs for that unit."

PRACTICAL ENGINEER SECTION

Fisher, after twenty years of experience, states that the type of current makes little difference. Direct current circuits are usually of lower voltage, but low voltage has caused burns just as serious as those caused by high voltages.

A dry skin is highly resistant to the flow of electricity and concentrates the effects, while a damp surface offers less resistance and tends to spread the injury over a larger area with less serious results. The degree of skin lesion also may depend upon the age of the worker since the skin becomes dryer with progressive age. Electric burns heal spontaneously although their healing usually is very slow.

Schwartz, Tulipan and Peck warn of neglect in treating small, what would appear to be superficial burns. Such neglect has frequently led to serious complications; conservative treatment is recommended. During the second or third week there is the possibility of complications. Skin grafting may be necessary after severe electric burns, and this is usually done as soon as the wound exhibits a healthy surface.

The vast majority of electric burns in industry, occur among mechanics and engineers working in electric power plants on distribution lines, since these men are more continuously exposed to the danger of contact with electrical conductors. As in all other forms of accidents electrical burns should be given first aid just as soon as possible.

BASIC POWER PLANT FIGURING—2

A Review for Old-Timers — A Must for Young-Timers

By WILLIAM H. ENGELMAN

IN WORKING with heat and steam, you are required to know the exact amount of heat supplied per pound of steam used, how much heat is in the steam (or water) and in addition you must often know the volume of the steam. These values, obtained for different pressures and temperatures, are all tabulated in the steam tables, for either saturated or superheated steam. Most authoritative tables are considered to be *Thermodynamic Properties of Steam* by Keenan and Keyes (John Wiley & Sons). Tables .., .. and .. show what small sections of these tables look like in the book. For actual use, you should have the complete tables, covering the complete ranges of pressures and temperatures.

Temperature Scales

Temperatures in American engineering are usually measured in degrees Fahrenheit and are given as 100 F or 200 F, the degree sign being usually omitted. On the Fahrenheit scale, temperature at which water freezes to ice is taken as 32 F, temperature at which it boils is taken as 212 F, both at atmospheric pressure.

In work with gases and other problems, you may need to use absolute temperature or Rankine temperature scale. On Rankine scale, absolute zero of temperature is taken as — 459.6 F but the value — 460 is used in ordinary engineering calculations. Thus a temperature of 32 F would be 32 + 460 = 492 Rankine or 492 R.

Centigrade temperature is used in scientific and chemical measurements but in most steam engineering you will not need it. To convert temperatures from Fahrenheit to Centigrade, use the formula 9/5 C + 32 = F. Thus 100 C would be 9/5 (100) + 32 = 212 F or 300 F would be (300 — 32) ÷ 9/5 = 148.8 C.

In the steam tables, all temperatures are given in degrees Fahrenheit. All pressures in the steam tables are given in pounds per square inch absolute (psia) or in inches of mercury (in. Hg), see Part 1. Thus, to look up values corresponding to 115 psi gage or 115 psig, look for them in the line opposite 129.7 psia (115 + 14.7 = 129.7) or for most ordinary work, 130 psia.

Symbols v_f and v_g in the tables indicate values for specific volumes of saturated liquid and saturated vapor respectively. These are in cubic feet per pound, which you often need to know in calculating volumes of piping, tanks, drums and the like.

Enthalpy

The columns headed enthalpy in the steam tables are the most important in heat calculations, for the term enthalpy represents Btu per pound of water or steam as the case may be.

Enthalpy replaces the former term total heat of steam because it is an energy term and includes both the internal energy and the external work or flow work. All values of enthalpy are in Btu per lb, one Btu being equal to 778.26 ft lb or 778 for most engineering work and 1 Btu being the amount of heat required to raise the temperature of 1 lb of water 1 degree F. The value now used is based on the heat equivalent of 1/860 kwhr, making it independent of the thermal properties of water.

In the table of enthalpy, term h_f under saturated liquid, is the number of Btu required to raise the temperature of 1 lb of water from 32 F to the boiling point for the existing pressure.

The symbol h_{fg} represents the heat added to a pound of water, at the given pressure, to change it from water into steam.

Finally, h_g, saturated vapor, represents amount of heat above 32 F added to a pound of water to convert it all to steam at the given pressure.

Figure 3 shows diagrammatically the amount of heat required to generate 1 lb of steam at 14.7 psia or atmospheric pressure. (Heat of saturated liquid h_f is 180.1

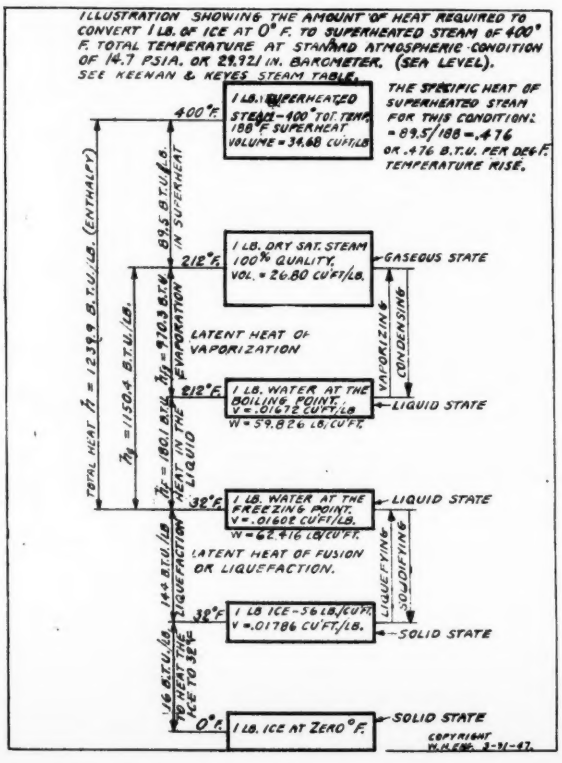
ILLUSTRATION SHOWING THE AMOUNT OF HEAT REQUIRED TO CONVERT 1 LB. OF ICE AT 0° F. TO SUPERHEATED STEAM OF 400° F. TOTAL TEMPERATURE AT STANDARD ATMOSPHERIC CONDITION OF 14.7 PSIA. OR 29.921 IN. BAROMETER. (SEA LEVEL). SEE KEENAN & KEYES STEAM TABLES.
1 LB. SUPERHEATED STEAM—400° TOT. TEMP. 188° F SUPERHEAT VOLUME = 34.68 CU.FT./LB.
400° F.
THE SPECIFIC HEAT OF SUPERHEATED STEAM FOR THIS CONDITION: = 89.5/188 = .476 OR .476 B.T.U. PER DEG F. TEMPERATURE RISE.
89.5 B.T.U./LB. IN SUPERHEAT
TOTAL HEAT h_g = 1239.9 B.T.U./LB. (ENTHALPY)
1 LB. DRY SAT. STEAM 100% QUALITY, VOL. = 26.80 CU.FT./LB.
212° F.
GASEOUS STATE
h_{fg} = 970.3 B.T.U. LATENT HEAT OF EVAPORATION
LATENT HEAT OF VAPORIZATION
VAPORIZING & CONDENSING
1 LB. WATER AT THE BOILING POINT. V = .01672 CU.FT./LB. W = 59.826 LB./CU.FT.
212° F.
LIQUID STATE
h_f = 180.1 B.T.U. HEAT IN THE LIQUID
TOTAL HEAT h_f = 1150.4 B.T.U./LB.
1 LB. WATER AT THE FREEZING POINT. V = .01602 CU.FT./LB. W = 62.416 LB./CU.FT.
32° F.
LIQUID STATE
144 B.T.U./LB. LIQUEFACTION
LATENT HEAT OF FUSION OR LIQUEFACTION.
LIQUEFYING & SOLIDIFYING
1 LB ICE—56 LB./CU.FT. V = .01786 CU.FT./LB.
32° F.
SOLID STATE
1.6 B.T.U./LB. TO HEAT THE ICE TO 32° F.
0° F.
1 LB. ICE AT ZERO° F.
SOLID STATE
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Fig. 1. Diagram of heat required to convert 1 lb of ice into steam at 400 F at 14.7 psia

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from the tables, rather than 180 from the temperature difference 212 — 32 because the specific heat of water varies. Specific heat is the quantity of heat required to change the temperature of 1 lb of any substance 1 deg. For water at 30 F, specific heat is 1.008, at 55 F it is 1.000, at 100 F it is 0.9967, at 160 F it is 1.0002, at 210 F it is 1.005.

Change from water to steam occurs at a definite and constant temperature that depends only on the pressure. Steam differs from a gas in that respect, because a gas can have different temperatures as a result of volume changes at constant pressure.

Changes occurring in formation of steam under various pressures, as heat is added, are shown in Figs. 1, 2, 3 and 4.

Explanation of the columns in the steam tables headed entropy and internal energy will be given later.

Superheated Steam

Superheated vapor tables show, for each pressure, the saturation temperature, the specific volume v, the enthalpy or total heat h and the entropy s for various values of total temperature.

Enthalpy per pound of superheated steam equals enthalpy per pound of dry saturated steam plus the heat required to change the temperature from that of saturation t_v to the desired total temperature, t_s.

Steam Quality

One more point must often be considered in using the steam tables: steam quality or wetness of the steam. Dry saturated steam results when all the water from which the steam is formed changes into vapor and no droplets of actual water are left unevaporated to remain suspended in the steam like a fog or mist. If a portion of a pound of water remains unevaporated, it is referred to as the moisture, while the portion of the water evaporated into dry steam is often referred to as the quality, both expressed in per cent of total weight.

Quality of steam is usually denoted by x as a decimal. Thus steam of 98% quality has x = 0.98 and 2% or 0.02 moisture. If you know the percentage of moisture, subtract that from 100 to get quality x.

Why is this important? Because all steam table values refer to dry saturated steam, quality x = 1.0 or 100 per cent. But in many cases, such as turbine or engine exhaust, where we know there is moisture or it can be measured or we must limit

Table I. Specimen section, to show style, from Table I, Temperatures, Keenan & Keyes Steam Tables. Tables I, II and III abstracted by permission from *Thermodynamic Properties of Steam*, by J. H. Keenan and F. G. Keyes, published by John Wiley & Sons, Inc.

Table 1. Saturation: Temperatures

Temp. Fahr. t	Abs. Pressure Lb. Sq. In. p	In. Hg.	Specific Volume Sat. Liquid v_f	Evap. v_{fg}	Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Entropy Sat. Liquid s_f	Evap. s_{fg}	Sat. Vapor s_g	Temp. Fahr. t
200°	11.526	23.467	0.01663	33.62	33.64	167.99	977.9	1145.9	0.2938	1.4824	1.7762	200°
202	12.011	24.455	0.01665	32.35	32.37	170.00	976.6	1146.6	0.2969	1.4760	1.7729	202
204	12.512	25.475	0.01666	31.14	31.15	172.02	975.4	1147.4	0.2999	1.4697	1.7696	204
206	13.031	26.531	0.01667	29.97	29.99	174.03	974.2	1148.2	0.3029	1.4634	1.7663	206
208	13.568	27.625	0.01669	28.86	28.88	176.04	972.9	1148.9	0.3059	1.4571	1.7630	208
210°	14.123	28.755	0.01670	27.80	27.82	178.05	971.6	1149.7	0.3090	1.4508	1.7598	210°
212	14.696	29.922	0.01672	26.78	26.80	180.07	970.3	1150.4	0.3120	1.4446	1.7566	212
214	15.289	31.129	0.01673	25.81	25.83	182.08	969.0	1151.1	0.3149	1.4385	1.7534	214
216	15.901	32.375	0.01674	24.88	24.90	184.10	967.8	1151.9	0.3179	1.4323	1.7502	216

Table II. Specimen section, to show style, from Table 2, Pressures, Keenan & Keyes Steam Tables

Table 2. Saturation: Pressures

Abs. Press. Lb. Sq. In. p	Temp. Fahr. t	Specific Volume Sat. Liquid v_f	Sat. Vapor v_g	Enthalpy Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Entropy Sat. Liquid s_f	Evap. s_{fg}	Sat. Vapor s_g	Internal Energy Sat. Liquid u_f	Evap. u_{fg}	Sat. Vapor u_g	Abs. Press. Lb. Sq. In. p
170	368.41	0.01822	2.675	341.09	854.9	1196.0	0.5266	1.0324	1.5590	340.52	771.4	1111.9	170
172	369.35	0.01823	2.645	342.10	854.1	1196.2	0.5278	1.0302	1.5580	341.52	770.5	1112.0	172
174	370.29	0.01824	2.616	343.10	853.3	1196.4	0.5290	1.0280	1.5570	342.51	769.7	1112.2	174
176	371.22	0.01825	2.587	344.09	852.4	1196.5	0.5302	1.0259	1.5561	343.50	768.8	1112.3	176
178	372.14	0.01826	2.559	345.06	851.6	1196.7	0.5313	1.0238	1.5551	344.46	767.9	1112.4	178
180	373.06	0.01827	2.532	346.03	850.8	1196.9	0.5325	1.0217	1.5542	345.42	767.1	1112.5	180
182	373.96	0.01829	2.505	347.00	850.0	1197.0	0.5336	1.0196	1.5532	346.38	766.2	1112.6	182
184	374.86	0.01830	2.479	347.96	849.2	1197.2	0.5348	1.0175	1.5523	347.34	765.4	1112.8	184

Table III. Specimen section, to show style, from Table 3, Superheated Vapor, Keenan & Keyes Steam Tables

Table 3. Superheated Vapor

Abs. Press. Lb./Sq. In. (Sat. Temp.)		Sat. Liquid	Sat. Vapor	Temperature—Degrees Fahrenheit 340°	350°	360°	370°	380°	390°	400°	420°	440°	460°	480°	500°	520°	540°
	v	0.018	4.019	4.085	4.151	4.216	4.281	4.345	4.408	4.470	4.593	4.714	4.834	4.952	5.069	5.186	5.301
110	h	305.7	1188.9	1192.0	1197.9	1203.7	1209.4	1215.0	1220.5	1226.0	1236.7	1247.3	1257.7	1268.0	1278.2	1288.3	1298.4
(334.77)	s	0.4832	1.5948	1.5988	1.6062	1.6133	1.6202	1.6269	1.6334	1.6398	1.6521	1.6640	1.6754	1.6865	1.6972	1.7077	1.7179
	v	0.018	3.981	4.007	4.072	4.137	4.200	4.263	4.325	4.387	4.508	4.627	4.745	4.861	4.976	5.091	5.204
112	h	307.1	1189.2	1191.5	1197.5	1203.3	1209.0	1214.7	1220.2	1225.7	1236.4	1247.0	1257.4	1267.7	1278.0	1288.1	1298.2
(336.11)	s	0.4849	1.5934	1.5963	1.6037	1.6109	1.6178	1.6245	1.6311	1.6375	1.6499	1.6618	1.6732	1.6843	1.6951	1.7056	1.7158

Table IV. Selected values from Keenan & Keyes Steam Tables and Thermodynamic Charts by Ellenwood & Mackey, 2nd Ed., 1945, to show range of values

PROPERTIES OF SATURATED STEAM AT VARIOUS PRESSURES

Vacuum in. Hg or Press. psi p	Steam Temp. Deg F. t	VOLUME, CU FT per LB Sat. Liquid V_f	Sat. Vapor V_g	ENTHALPY, OR BTU per LB Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g
29" Vac.	79.03	0.01608	652.3	47.05	1049.2	1096.3
26" Vac.	125.43	0.01622	176.7	93.34	1022.7	1116.0
26" Abs.	205.00	0.01667	30.56	173.02	974.8	1147.8
14.7 psia	212.00	0.01672	26.80	180.07	970.3	1150.4
5.3 psig	227.96	0.01683	20.089	196.16	960.1	1156.3
100 psia	327.81	0.01774	4.432	298.40	888.8	1187.2
200 psia	381.79	0.01839	2.288	355.36	843.0	1198.4
300 psia	417.33	0.01890	1.5433	393.84	809.0	1202.8
450 psia	456.28	0.01950	1.0320	437.2	767.4	1204.6
650 psia	494.90	0.0203	0.7083	481.8	720.5	1202.3
1000 psia	544.61	0.0216	0.4456	542.4	649.4	1191.8
3206.2 psia	705.40	0.0503	0.0503	902.7	0	902.7

PROPERTIES OF SUPERHEATED STEAM AT VARIOUS PRESSURES AND TEMPERATURES

Steam Press. Psia p	Deg Superheat. F.	Total Temp. F.	Enthalpy Total BTU H	BTU in Superheat	Specific Heat per °F	Volume Cubic Feet per Lb
14.7	68	280	1183.3	32.9	0.484	29.70
100	92	420	1238.1	50.9	0.553	5.071
200	118	500	1268.9	70.5	0.598	2.726
300	163	580	1303.7	100.9	0.619	1.9594
450	204	660	1337.5	132.9	0.651	1.3967
650	355	850	1433.3	231.0	0.651	1.1459
1000	355	900	1448.2	256.4	0.722	0.7604

Note: Values are taken from *Thermodynamic Properties of Steam* by J. H. Keenan and F. G. Keyes, published by John Wiley & Sons, Inc., and from the Thermodynamic Charts by Ellenwood & Mackey, 2nd Ed., 1945.

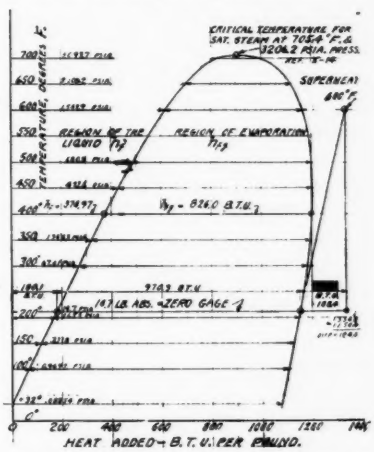
CRITICAL TEMPERATURE, FOR SAT. STEAM AT 705.4 °F. & 3206.2 PSIA. PRESS.
SUPERHEAT 600°F
REGION OF THE LIQUID
REGION OF EVAPORATION
v_{fg} = 826.0 B.T.U.
14.7 LB ABS. = ZERO GAGE
HEAT ADDED → B.T.U. PER POUND

Fig. 2. Diagram of changes occurring in water during formation of 1 lb of steam. Plotted from Keenan and Keyes steam tables

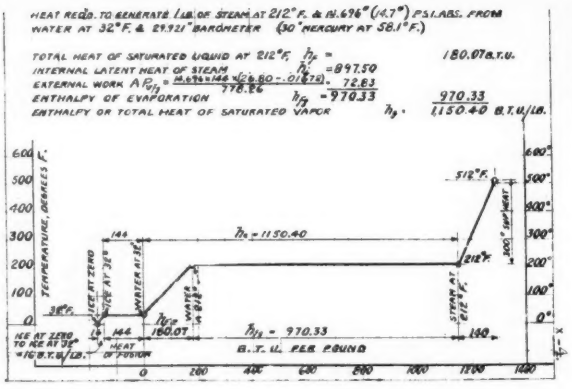
HEAT REQD. TO GENERATE 1 LB. OF STEAM AT 212° F. & 14.696" (14.7") P.S.I. ABS. FROM WATER AT 32° F. & 29.921" BAROMETER (30" MERCURY AT 58.1° F.)
TOTAL HEAT OF SATURATED LIQUID AT 212° F. h_f = 180.07 B.T.U.
INTERNAL LATENT HEAT OF STEAM h_i = 897.50
EXTERNAL WORK AP_{vg} = 14.696 × 144 × 26.80 ÷ 778.26 = .017 × 70. = 72.83
ENTHALPY OF EVAPORATION h_{fg} = 970.33
ENTHALPY OR TOTAL HEAT OF SATURATED VAPOR h_g = 970.33 / 1150.40 B.T.U./LB.
TEMPERATURE, DEGREES F.
212° F.
300° SUPERHEAT
144
h_g = 1150.40
WATER AT 32°
ICE AT ZERO
ICE AT ZERO TO WATER AT 32°
h_{fg} 180.07
WATER AT 212° F.
STEAM AT 212° F.
h_f = 970.33
150
ICE AT ZERO TO ICE AT 32° = 144 B.T.U. LB./LB.
HEAT OF FUSION
B.T.U. PER POUND
0
200
400
600
800
1000
1200
1400

Fig. 3. Diagram showing how heat is added to 1 lb of water to form 1 lb of steam at 212 F, 14.7 psia from water at 32 F

it, or calculate how much it is, we must take the quality into account. How this is shown on the Mollier diagram will be explained later.

In using the steam tables, if we have a pound of steam containing some moisture, the total heat in it will be less than if it were all vapor, because we have added heat of the liquid to all the water, but we have added the heat of evaporation to only a part of it. Thus, enthalpy h_w per pound of wet steam is $h_w = x\,h_{fg} + h_f$. If quality is 0.97, that means we have raised all of the pound of water to boiling point and then have added only enough heat to evaporate 97 per cent of it into steam.

At atmospheric pressure, if steam is dry and saturated it will contain 1150.4 Btu per lb. But at 97 per cent quality it will contain (above 32 F) only 0.97 × 970.3 + 180.1 = 1121.3 Btu.

All the foregoing steam values and calculations are for heat put into steam starting with water at 32 F.

In practice, we seldom start with 32 F water.

But in practice, what we usually want is how much heat is required to form w pounds of steam from water at some temperature other than 32 F, say 60, 70 or 80 F, common temperatures of natural waters except in winter. Or we want to know how much heat is released by steam when it condenses.

Example: Suppose we have 8 lb of water at a temperature of 182 F to turn into steam at 185.5 psig having a quality x of 0.98 and that the barometer reads 29.5 in. Hg. How much heat required?

Pressure of atmosphere =
$$29.5 \times 0.491 = 14.5 \text{ psi}$$

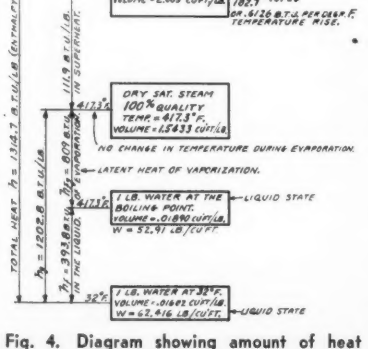
SUPERHEATED STEAM 600° F. TOTAL TEMP. 182.7° F. SUPERHEAT VOLUME = 2.005 CU.FT./LB.
THE SPECIFIC HEAT OF SUPERHEATED STEAM FOR THIS CONDITION IS 115.9 / 182.7 = .6126 OR .6126 B.T.U. PER LB. PER DEG. F. TEMPERATURE RISE.
600°
417.3°
DRY SAT. STEAM 100% QUALITY TEMP. = 417.3° F. VOLUME = 1.5433 CU.FT./LB.
NO CHANGE IN TEMPERATURE DURING EVAPORATION.
LATENT HEAT OF VAPORIZATION.
417.3°
1 LB. WATER AT THE BOILING POINT. VOLUME = .01890 CU.FT./LB. W = 52.91 LB./CU.FT.
LIQUID STATE
32°
1 LB. WATER AT 32° F. VOLUME = .01602 CU.FT./LB. W = 62.416 LB./CU.FT.
LIQUID STATE
TOTAL HEAT h_t = 1314.7 B.T.U./LB. (ENTHALPY)
h_g = 1202.8 B.T.U./LB.
h_{fg} = 809.8 B.T.U./LB. OF EVAPORATION
h_f = 393.88 B.T.U./LB. IN THE LIQUID
115.9 B.T.U./LB. IN SUPERHEAT

Fig. 4. Diagram showing amount of heat required to convert 1 lb of water at 32 F into steam at 300 psia, 600 F

Absolute steam pressure =
$$14.5 + 185.5 = 200 \text{ psia}$$

Enthalpy per lb steam h_w =
$$(x h_{fg} + h_f) - h_{f1}$$

Term h_{f1} is the amount of heat already in the water above 32 F, or $t - 32 = 182 - 32 = 150$ Btu already in the water above 32 F that we don't have to add. From the complete steam table or from Table IV we see that $h_{fg} = 843$ and $h_f = 355.36$. So that for 1 lb steam $h_w = [(0.98 \times 843) + 355.36] - 150 = 1031.4$ Btu. For 8 lb steam $8 \times 1031.4 = 8251.2$ Btu to be supplied by some source of heat.

But if we wanted to get dry saturated steam, we would have to add $(843 + 355.36) - 150 = 1048.4$ Btu per lb or, for 8 lb, 8387.2 Btu.

Example: How much heat is required to produce 10 lb of steam superheated 118 F when the pressure is 200 psia and temperature of the water from which it is formed is 80 F?

$$h_s = h_g + c_p\,(t_s - t_v)$$

Term c_p is the specific heat, which is not a constant, but varies with the pressure and temperature. Hence the heat required to change the temperature from t_v, the saturated steam temperature to t_s the final superheated steam temperature is c_p ($t_s - t_v$). Values of specific heat of superheated steam are given in various places, e.g., Fig. 28, *Elementary Steam Power Engineering*, MacNaughton.

Now h_g for 200 psia = 1198.4 — (80 — 32) and $c_p = 0.598$, so $h_s = 1150.4 + (0.598 \times 118) = 1150.4 + 70.6 = 1220.9$ Btu per lb or 12,209 Btu for the 10 lb.

From the table, you can read direct the total of 1268.9 Btu per lb and subtract from that 80 — 32 = 48 Btu for the heat in the water above 32, hence the total heat per lb is 1228.9, a fair check, the difference being due to differences in specific heats.

Interpolation

One thing more—Interpolation. Sometimes the values you must find fall between tabular values and you must interpolate or read between. In doing this, you must note the direction in which the quantities vary. Suppose you want h_{fg}, enthalpy of evaporation for 162 psia. It is tabulated for 100 psi and 200 psi thus, in Table IV.

	h_{fg}
100 psi	888.8
200 psi	843.0

Now 162 is 62/100 of the way between. The pressure numbers, however, are increasing while the h_{fg} numbers are decreasing. So required h_{fg} will be 62/100 of the way **down** from 888 to 843. From 888.8 to 843 is 45.8 units down; and $0.62 \times 45.8 = 28.396$. So we have 888.3 — 28.396 or, rounding off, 888.3 — 28.4 = 879.9 = h_{fg} for 162 psia.

NEXT TIME: More details on how to interpolate in steam tables.

PRACTICAL HINTS AND KINKS

KEEP YOUR FLASHLIGHT IN WORKING ORDER

By THOMAS TRAIL

A MANUFACTURER of flashlights at one time ran a series of advertisements, in which instances were described where the possession of a workable flashlight had saved lives, prevented injury, or staved off panic. I have wondered since, however, how many other instances have occurred where the failure of a flashlight at some critical moment has resulted in death or disaster.

How often have you snapped on your flashlight to make some casual plant examination only to discover that it gave but a feeble glow, or none at all? Under ordinary circumstances this is usually merely annoying, but it can be serious. When a fuse suddenly blows and plunges the place into inky blackness, how can you know, without a light, just where a spinning wheel or an unprotected switch may be awaiting your unwary step? It will be difficult and dangerous for you to even replace the blown fuse, in order to restore the lights.

A workable flashlight is both a convenience and a necessity, and should be kept in good order at all times, so that when needed it will be ready. Keeping a flashlight in good working order usually requires only a few minutes time, about once

Fig. 1. Keeping a flashlight in order

a month, for a general checkup, and renewal of the batteries promptly when the light output diminishes sufficiently to become noticeable.

To check your flashlight thoroughly, take it apart, examine each part and remove any dirt, rust or corrosion that may be present. A damp

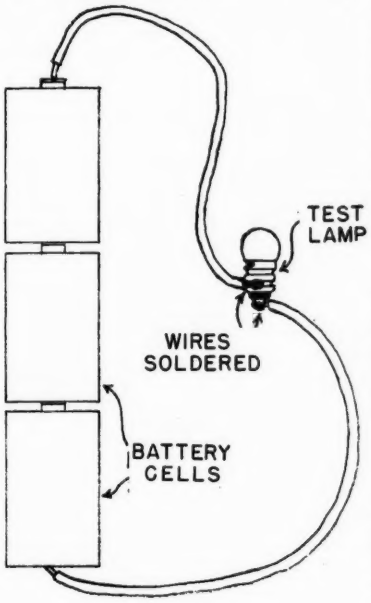

FIG. 2

Fig. 2. Testing flashlight battery

cloth dipped in scouring powder will remove dirt or grease, but usually sandpaper is necessary for the rust removal. Current-carrying parts must be free of rust, corrosion and dirt, since the low voltage employed in flashlights necessitates good electrical contacts if full brightness is to be obtained.

See that the batteries are free to slide in the case, to insure their maintaining good electrical contact with the lamp. Dents or warping of the case, that will hinder free movement of the batteries, should be eliminated. If the spring fails to exert sufficient pressure on the batteries, remove it from the case and

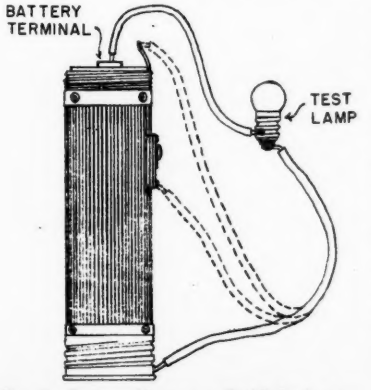

Fig. 3. Testing fiber case flashlight by bypassing the switch

stretch it out a little. Avoid excessive spring pressure, however, as this may force the batteries against the lamp too hard and damage the lamp base.

Next, examine the switch for excessive tightness or looseness. A tight switch may be made to work easier with a drop of thin oil. If the switch is too loose, it may be possible to tighten it by tightening the fastening rivets a little with light hammer blows.

Check the base of the lamp to see that it is not damaged. Also make sure that any spring brass contact strips inside the case are exerting sufficient current-carrying pressure. If not, bend them slightly to insure their doing so.

Polish the lamp reflector with powdered lamp black on a cloth. This will prevent scratching the highly polished surface. The glass or composition lens may be washed in soap and water. It should then be rinsed well to remove all traces of soap. Never use harsh or scratchy cleaners on the reflector or lens.

Reassemble the flashlight carefully, being sure that the lamp is properly seated in its socket. If the batteries fail to give a reasonably good light they should be replaced with new ones. Old batteries may not only fail when needed but may swell and corrode the inside of the flashlight. This is why exhausted batteries should never be left in a flashlight, unless they are of a type that cannot cause damage.

Dated batteries should be put in service before the expiration of the marked date, to insure best performance. Some batteries, however, are not dated, being designed to last indefinitely until used. These, of course, should not be discarded unless they show evidence of dimming.

In addition to periodic checkups, a flashlight should be given reasonable care when in use. Avoid dropping or striking it, or throwing tools on it. Do not use it for a hammer, or stand it on the lens end, as this may scratch the lens and prevent it from giving a bright light. If your flashlight gets wet, take it apart as soon as possible and dry each part with a dry cloth. This will prevent rust or corrosion forming between the parts.

Since a lamp may burn out unexpectedly, it is a good idea to keep a spare lamp conveniently available for replacement. Some flashlights are provided with a clip in the hollow end cap in which to carry one or more spare lamps. Even if your flashlight does not have such a provision, if sufficient spare room exists in the end cap, wrap a bit of cloth around a spare lamp and keep it in this unused space, if there is room for it.

If not, keep a spare near each flashlight location.

For most plant maintenance work, a two or three-cell standard flash-

PRACTICAL ENGINEER SECTION

light, with small head and polished reflector, will usually prove satisfactory. The three-cell type is useful where light must be transmitted considerable distances, such as in elevator or conveyor shafts, pipe tunnels, smokestacks, and similar applications. But for ordinary medium and close range maintenance lighting, a two-cell flashlight is more convenient to carry, since it can be slipped into a pocket. Very compact and pen type flashlights are useful to those having only occasional use for a light, and then only in a small quantity.

Some types of maintenance work can better be handled with a porta-

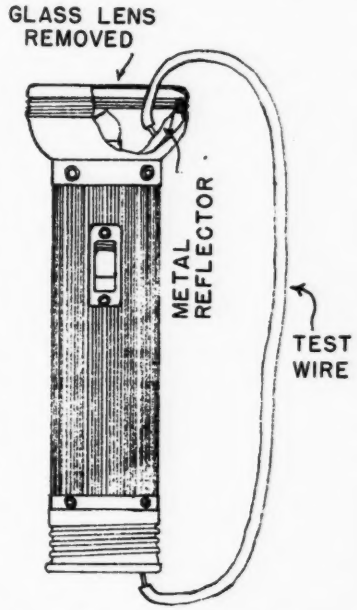

Fig. 4. Testing parts of circuit of fiber case flashlight

ble lantern. These usually operate on full-size dry batteries and are capable of producing larger quantities of light where needed.

For certain types of work, where it is necessary to see around obstructions or into locations difficult of access, flashlights are available having flexible rod ends that will conduct light in any direction. This is an especially useful feature for examining motor bearing oil rings, the interiors of fractional horsepower motors, and similar applications.

Where a number of duplicate flashlights are in service around a plant, the rechargeable flashlight battery may prove an advantage from an economy standpoint. This type battery is the same size as two regular flashlight cells and hence fits

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in any standard two-cell flashlight. However, since the voltage is slightly lower than that of two conventional cells, a lower voltage lamp should be employed in order to obtain brightness comparable with that of the higher voltage regular type cells. These lamps may be obtained from the battery manufacturer.

Chargers are available in sizes to recharge from one to six batteries. Usually an overnight charge each night is sufficient to maintain the batteries in daily service. The instructions accompanying this type of battery should be followed carefully, especially as regards maintaining the proper quantity of water in the battery. These batteries also require more careful handling than conventional cells. They are constructed of plastic and, while possessing considerable strength, can be damaged by unusually rough handling. Like any other storage type battery, a cracked or broken case will render the unit unserviceable.

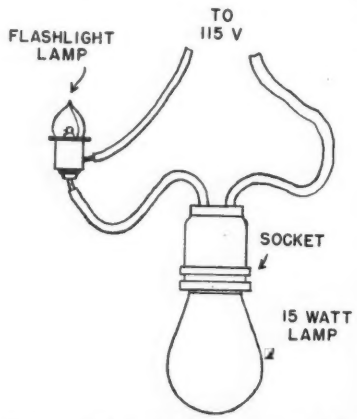


Fig. 5. Testing flashlight lamp on 115-v circuit

A flashlight can be faithful and comforting friend when needed. Treat your flashlight with care and it may someday save you from a serious accident.

A PRACTICAL TESTER FOR RADIATOR TRAP ELEMENTS

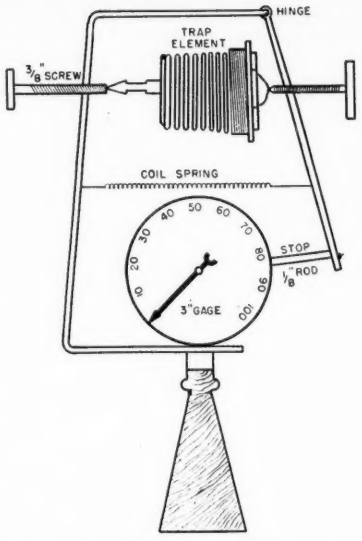
By N. W. DUELL

WHILE WORKING as Engineer in a hospital where we had several buildings to be heated by steam with a vacuum system, there was a heterogeneous variety of radiator traps. Some of them had nearly outlived their usefulness, and we were at a loss, because we had no way to determine how good or bad the elements were. So I built the apparatus shown in the sketch.

It consists of a frame made of bar steel, ¼ in. by 1 in., bent as shown, with one side hinged as per illustration. An old 3 in. steam gage is used for the dial, with a small rod hooked to the Bourdon tube and attached to the hinged arm. Two ⅜ in. screws passing through the frame act as supports for the element to be tested.

The apparatus is upended in a bucket of boiling water until the element is submerged. If the element is good, the gage will show about 50 on the dial. If there is no movement of the pointer, the element may be discarded as useless.

I used a ⅜ in. screw because it has 16 threads to the inch, one turn equaling .0625 in. so that when the element cools and the dial returns to zero, then by turning the screw in until the gage reads 50 again (or whatever the previous reading was) and noting the turns or fractions of a turn, the exact expansion can be computed. The coil spring keeps a tension on the hinged arm and holds it to the stop, or zero, position.



Sketch of testing device for radiator trap elements devised by N. W. Duell

LETTERS AND COMMENTS

MORE ON SHARP TOOLS— AND HOW ABOUT COPPER-ALLOY TOOLS?

MR. REYNOLDS' remarks on the sharpening of tools, in the January issue of POWER GENERATION, were very interesting. (Sharp Tools Save Labor, Make Jobs Easier, by John G. Reynolds, January issue, page 86).

His opening "Ever try to bore a hole with a rusty bit?" could be repeated so many times, naming different tools.

Simple mechanical everyday tools —chisels, axes, screwdrivers — are often ruined at the first grinding, due mainly to lack of "know-how" in the art of tempering. Often a piece of steel that has lost its temper, due to careless grinding, is thrown away as "no-good, bum, sonova-so'n'-so piece of cheap steel!"

A lot of us don't know too much about the art of tempering tools. Some of us picked up valuable pointers in some old "smithy." We added to our knowledge, perhaps, with a little reading. Fortunate, indeed, is a young mechanic if he is initiated into the "secret" of tempering tools by a willing old-timer. Eventually, the ambitious young mechanic would learn from his own efforts. But every trade has its tricks.

Without going into philosophy too deeply, there is a right and wrong way of doing things. From experience, the old-timers have learned pretty nearly all the old, good ways of doing things. I wonder if some of them could be induced to put in writing their experiences in tempering steel tools and hardening copper cutting-tools.

In this plant we are limited, in certain parts, to the use of copper-alloy spark-proof tools. The hardening of these is the reverse of tempering steel tools. The hotter these tools get from grinding, the harder they get—up to a certain

point,—if you allow them to cool very gradually.

As I pointed out, the old blacksmiths had tempering down to an art. Indeed, one of them had the honor of tempering the "Sword of Stalingrad." They did not know too much about copper cutting-tools.

We read, or hear, that the old Egyptians had the secret of tempering copper to the same hardness as steel. Maybe some readers of POWER GENERATION knew, or know some Egyptians? They may have the Art and would perhaps, hand it on down through the columns of *Practical Engineer*.

Morristown, N. J. WM. J. HARDING

Questions and Answers

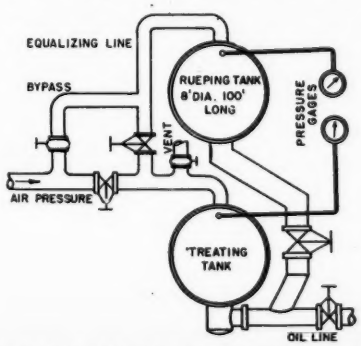
Answer No. 387
FINDING SIZE OF FILLING AND EQUALIZING PIPES

IN THIS PROBLEM, originally presented several months ago, were two tanks, one a Rueping tank containing a treating oil, the other containing wood to be treated, connected as shown on page 76, December 1948 issue.

The lower tank is to be filled from the upper tank in 10 min. How do you calculate the size of filling and equalizing pipes?

In the December, 1948 issue, L. Slote and Y. Yavitch both gave details of the method for analyzing this by calculating the variable head by decrements as the upper tank is emptied. They figured both ways:—the size of pipe required to empty the upper tank in 10 min. and the length of time it would take to empty the tank through an 8-in. pipe.

Here is a comment on the problem to the effect that the above method of calculation, while very accurate, involves a lot of work and that the method using average heads is close enough. But this comment also introduces another idea; to make the upper tank empty faster through a smaller pipe, put air pressure on the tank (assuming that air would not react chemically with the treating solution).



Sketch by Moulton showing connections of treating tanks and use of differential air pressure

Use Air Pressure, Says Moulton

B.E.'s PROBLEM is one of the kind sometimes described as a Head Scratcher, because it involves calculating the discharge of a given quantity of fluid through a given size of pipe under a varying head. Now this varying head is "what made the wild man wild"; for, theoretically, only an infinitesimal amount of fluid could flow out of tank without changing the head a like amount and we could go on forever calculating the infinite number of heads that would develop in emptying the tank. But, fortunately, it is not necessary to go to all this vast amount of calculation, which would consume more than a life time.

And suppose we did:—in the end, the sum of heads thus found divided by the number taken would be the average head. So why not do it the easy way; that is, take ½ of the total head for the average? Let's do that and see how we come out.

Now the static head is the hydraulic depth and is independent of the surface area of the liquid surrounding the point taken, for example, the static head in a ½-in. vertical pipe having 8 ft of water in it is the same as it would be in the middle of a lake at a depth of 8 ft, which is the depth of the full tank given in this problem.

Average discharge head $H = 4$ $v = \sqrt{2 \times 32.2 \times 4} = 16.04$ ft. per sec.

Also $v = 8.02 \times \sqrt{4} = 16.04$ ft. per sec.

V = volume of tank $= 8 \times 8 \times 0.7854 \times 100 = 5025$ cu. ft.

Q = cubic feet per min. $= v \times a$

C_d = coefficient of discharge = 0.61 or 61% of the theoretical.

t = time in minutes

Area 8-in. pipe = 51.16 sq in. or 0.355 sq ft.

As real flow of liquids is always less than theoretical, because of its resistance to flow we must use a factor that will give the correct flow or nearly so. The time in minutes to empty tank through an 8-in. pipe = $V \div Q$ min.

$Q = 60\ (8.02 \times 2 \times 0.61 \times 0.355) = 208.4087$ cu. ft. per. min.

Then $t = 5025 \div 208.4087 = 24$ min. approximately

The size pipe required to empty it in 10 min must have an area of $51.16 \times (24.2 \div 10) = 129$ sq. in. So its diameter is $\sqrt{129 \div 0.7854} = 13$ in.

Now if it were feasible to maintain a slightly higher air pressure in the Rueping tank than in the treating cylinder when filling the latter tank, it could be emptied in the 10 min through the 8-in. pipe and save making the change, by installing a bypass around gate valves in equalizer and air supply pipes, as shown in sketch, closing air valve and equalizer valve and opening vent valve enough to give the required differential.

This, of course, requires a pressure gage on each tank. The total head required to give the flow to empty tank in 10 min through an 8-in. pipe can be calculated as follows:

$\sqrt{H} = 5025 \div (60 \times 10 \times 8.02 \times 0.61 \times 0.355) = 4.82$

$H = (4.82)^2 = 23.23$ ft total head

Then the additional head $= 23.23 - 4 = 19.23$ ft.

Air pressure to give equivalent head $= 19.23 \times 0.434 = 8$ psi.

The equalizer pipe does not need to be larger than 3 in. or some convenient size.

Pittsfield, Mass. ALBERT H. MOULTON

Answer No. 423
HOW CALCULATE CONDENSER SPRING SUPPORTS?

METHOD OF analyzing spring supports on condensers bolted to and hung directly from the turbine exhaust flange, was requested by F. H. John Kalman gave some practical data on the way these springs are installed. Here is another comment on design and construction.

Turbine Flange Stress Must Be Down

ON A JOB of this type the spring supports must hold turbine flange stress between a definite minimum and maximum. Stress on turbine flange must always be downward.

Roughly, $N_w = (W_1 + W_2 + W_3) - (SF)$

Where N_w = Normal weight supported by springs

W_1 = Weight of condenser

W_2 = Weight of water in tubes and water boxes

W_3 = Weight of condensate at normal hotwell level

SF = Maximum allowable stress in pounds on turbine exhaust flange.

It can be safely said that adjustments can always be made by the plant operators when for any reason the condenser is to be flooded,

for this added weight in some cases will equal the weight of the condenser.

Regarding a new installation, the turbine and condenser manufacturers should put their heads together and arrive at proper support setting. I believe setting is carried out approximately as follows; the empty condenser is rested on the springs at low spring set. The exhaust casing of turbine is aligned and secured. By use of the adjustment screws below spring bearing plates, the condenser flange is elevated until the joint can be made with exhaust flange of turbine. As the condenser is put in actual service the screws are readjusted to compensate for added weight and to place the desired downward stress on the turbine flange.

Baltimore, Md. MARVIN M. PERSINGER

Answer No. 435

WHY DID NIPPLE CAUSE SAFETY VALVE TO BLOW INCORRECTLY?

ON THEIR new 140-psi boiler, a new safety valve, received with the factory setting of 140-psi, was installed. When the boiler was first fired up, the valve popped at 75 psi on several tries.

The boiler was shut down and the safety valve was removed and tested and found to lift correctly on test at 140 psi. Pressure gages were checked against known gages, too, and found correct. But when the valve was replaced and the boiler fired up again, the valve again lifted at 75 psi.

Then the valve manufacturer's service man found that a pipe nipple 12 in. long had been placed between the boiler outlet and the safety valve. When this nipple was removed and the valve installed directly on the boiler outlet, it popped correctly at 140 psi.

The service man's explanation was that the nipple caused a partial vacuum that made the valve lift at 75 lb. How could that be, asked L.T., when there was 75 psi pressure to make the valve lift?

(Editor's Note—Here, as in many questions, much information is omitted. For example, we asked for the diameter of the pipe nipple but never received it. Also, did the valve pop at 75 psi or just open slowly? Did it chatter at 75 psi? And so on? But some of the following discussion brings out several points that may help explain what happened.)

Long Nipple Could Cause Erratic Action

ONE of the engineers of a manufacturer of safety valves says:

"I am at a loss to understand how the safety valve in question could have operated as explained. I don't follow the valve manufacturer's field engineer's explanation that the nipple between the boiler shell and the valve itself caused a partial vacuum and that this vacuum caused the valve to blow at 75 psi rather than the stamped nameplate value of 140 psi.

"We have had no such experience as this on which I could draw for a suitable answer to your question. Normally, if the valve is mounted a considerable distance from the source of generation, we have found that the valve would open at the stated pressure, but the valve would, perhaps, open and close repeatedly under such circumstances if the intervening connection was unduly long; because the pressure drop in the intervening pipe caused by the opening of the valve would be less than the closing point of the valve. Therefore, the valve would open, the pressure in the intervening pipe would be reduced below the closing point of the valve, and the valve would immediately close. Following this, the pressure underneath the valve would be brought up to the opening point of the valve and the sequence of operations would be repeated."

Mechanical Strains Might Do It

TO BEGIN WITH, the installation of the 12 in. nipple between the safety valve and the boiler was in violation of the ASME code, which limits this distance to an amount not to exceed that of the height of a standard tee of the same pipe size.

It is possible that, because of faulty support, bad threads, uneven bolt tightening, and the like, the safety valve, when mounted on the end of the pipe nipple, was under a mechanical strain causing misalignment of the spindle, valve, valve guide, seat, or binding of the spring, this might cause enough leakage to expose a greater area of the valve disc resulting in opening at a lower pressure.

L. T. stated that the valve lifted at 75 psi, but did not state whether it did so with a pop. If the valve did not open with a sudden pop when it was mounted at the end of the pipe nipple, that would tend to support the theory expressed above.

As to the existence of a vacuum below the valve disk, with 75 psi steam pressure behind it, of course I do not believe it. But it might be possible that, if the valve disk leaked enough at 75 psi, due to misalignment, the resultant velocity of the steam flow across the blow-back adjusting ring might tend to cause a partial vacuum above the valve disk, which in turn might cause the disk to lift a little higher.

I consider it fortunate that L.T. ran into trouble with his original installation because, even though the valve had been in perfect alignment and popped at the set pressure, the relieving capacity of the valve would probably have been less, due to the added pressure drop across the 12 in. length of pipe.

St. Louis, Mo. JESSE L. ERISMAN

Pressure Drops in Pipe Would Explain It

Another engineer for a second manufacturer of safety valves comments as follows:

"If safety valves are of the type where steam can get on top of the pistons, then such valves must not be connected up with pipe or fittings between the boiler and the valve. If this is done, such valves may chatter, that is, open and close rapidly owing to the drop in pressure under the valve seat caused by the restriction to the flow offered by the piping or a reduction in the diameter of the piping.

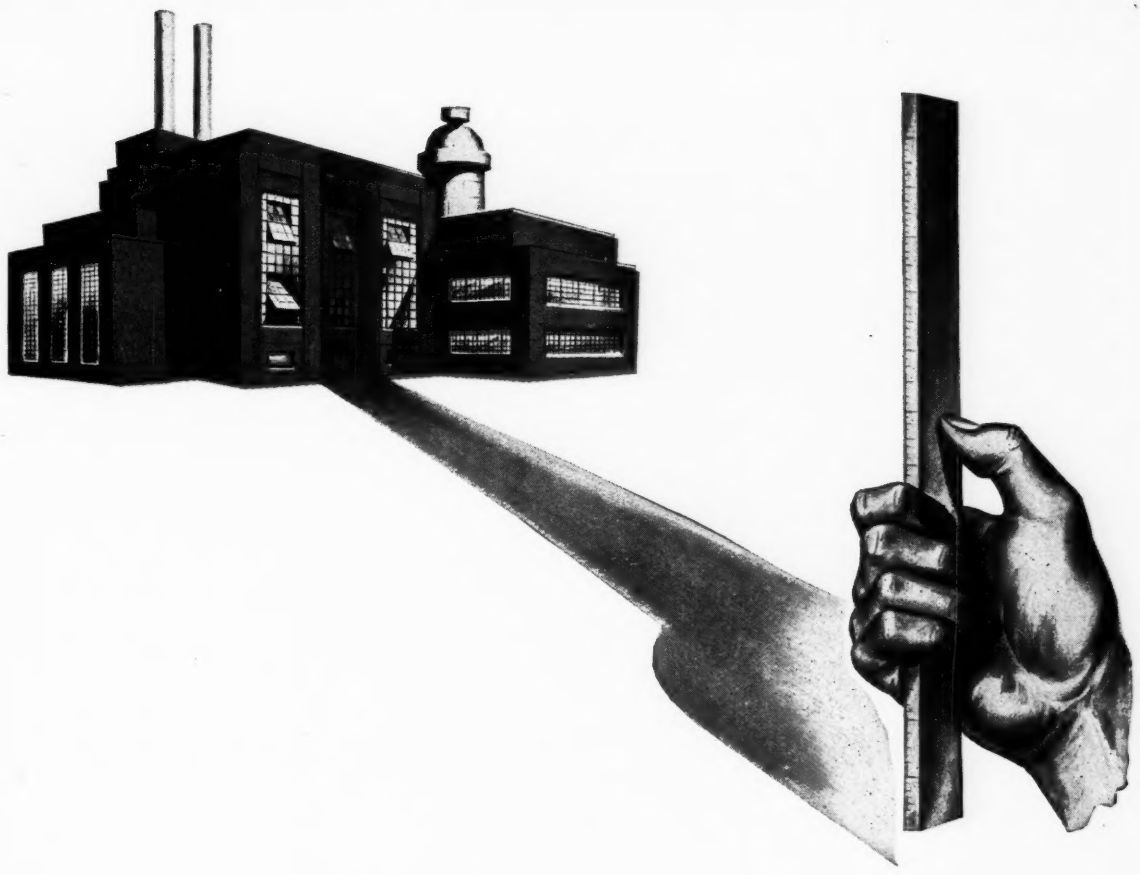
"The discharging piping from all safety valves should be arranged so as not to cause back pressure; hence any decrease in size of the piping to a safety valve is *absolutely forbidden* in that it means double orifices, which will always cause a reduction in the capacity of the valve.

"It would appear that the area of the pipe nipple diam 12 in. long, of which they speak, might have been roughly half the area of the pipe from the boiler to the nipple and then to the valve. If that is so, then the pressure in the pipe from the nipple to the valve would be about half the boiler pressure, and, of course, the second orifice of the valve would only have about one half of its designed capacity. This would be a most dangerous safety valve installation, in that chatter might have been expected, aside from the double orifices and the undesirable reduction in the safety valve capacity.

"The chances are that there was no vacuum in the line, and further if the gage had been very carefully read it should have for a slight instant reached 140 psi, but then promptly dropped back to 75 psi, which was the pressure drop in the line, all due to the ratios of areas between the nipple where the pressure was 140 psi to 75 psi in the line from the nipple to the valve.

"If there were no sharp edges in the inlet and the outlet of the nipple, the pressure can be readily calculated; however, as a rule such pipe fittings are rather sharp, which will further cut down the pressures.

"The case is very similar to a plain piston valve engine, in that the pressures can readily be determined, for each position of the piston, after the steam has been cut off; that is, the ratios of the initial pressure at the point of cut-off to any positions of the piston in the entire stroke to the point of the exhaust valve opening."



How Well Does *Your* Boiler Plant Measure Up?

The effectiveness of your water conditioning can well be the yardstick of your boiler plant operation. How much *or how little* boiler water trouble you have is a true measure of successful, economical boiler plant operation. Consider then, "How well does *your* boiler plant measure up?"

Trouble-free operation is a result of scientific control.

W. H. & L. D. BETZ is an organization of engineers and chemists specializing in the solution of all industrial water problems. Years of experience have made Betz water conditioning service scientifically correct . . . complete . . . economical.

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BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

How to Use Heat Balance in Improving Industrial Power Plants

By H. C. CARROLL
Commercial Testing
& Engineering Co.

Where increasing production demands are overtaxing old industrial power plants, competition increasing, fuel costs rising, survey must be made to decide on improvements . . . How this was done in a typical process plant . . . To calculate heat balance of present plant, must have proper instruments to determine present conditions . . . First, make complete piping and electrical diagrams, locate meters . . . Second, collect necessary data over long enough period . . . Third, tabulate and graph heat and power requirements . . . Fourth, balance these against possible ways of providing them . . . In specific case studied, purchased power was eliminated, higher pressure boilers and extraction turbines will save $80,000 to $100,000 a year

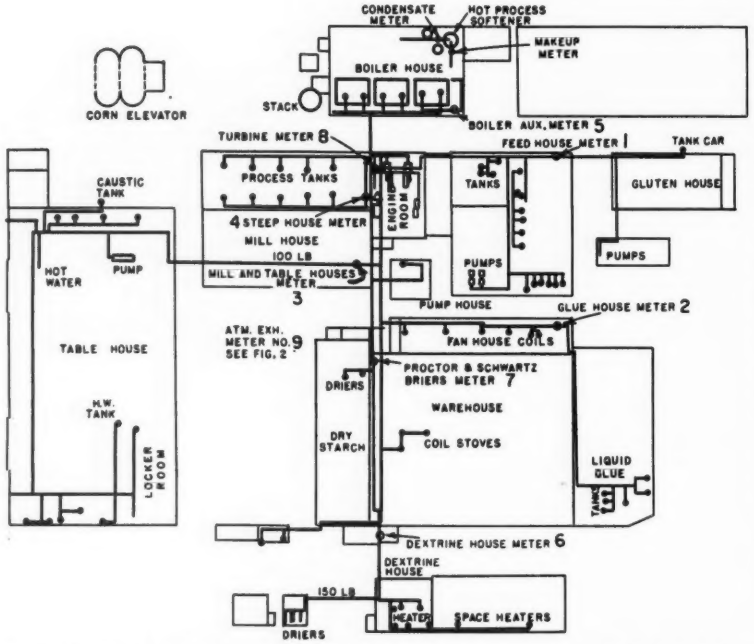


Fig. 1. Layout of high-pressure steam distribution lines for typical industrial plant being surveyed

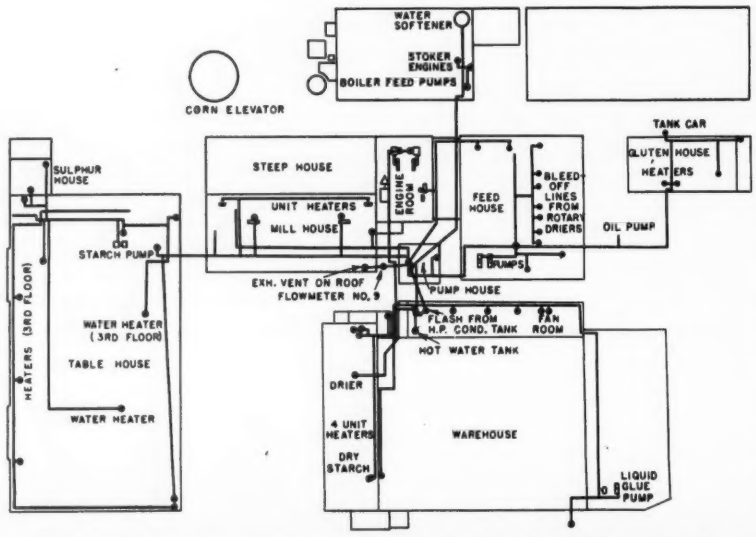


Fig. 2. Layout of low-pressure steam lines for typical industrial plant being surveyed

IN INDUSTRIAL PLANTS using various pressures and temperatures, large quantities of low and high-pressure steam, hot and cold water, and electrical energy covering a wide range of processes, a heat balance analysis is essential as a basis for the study of improvements in economy or economical increased production.

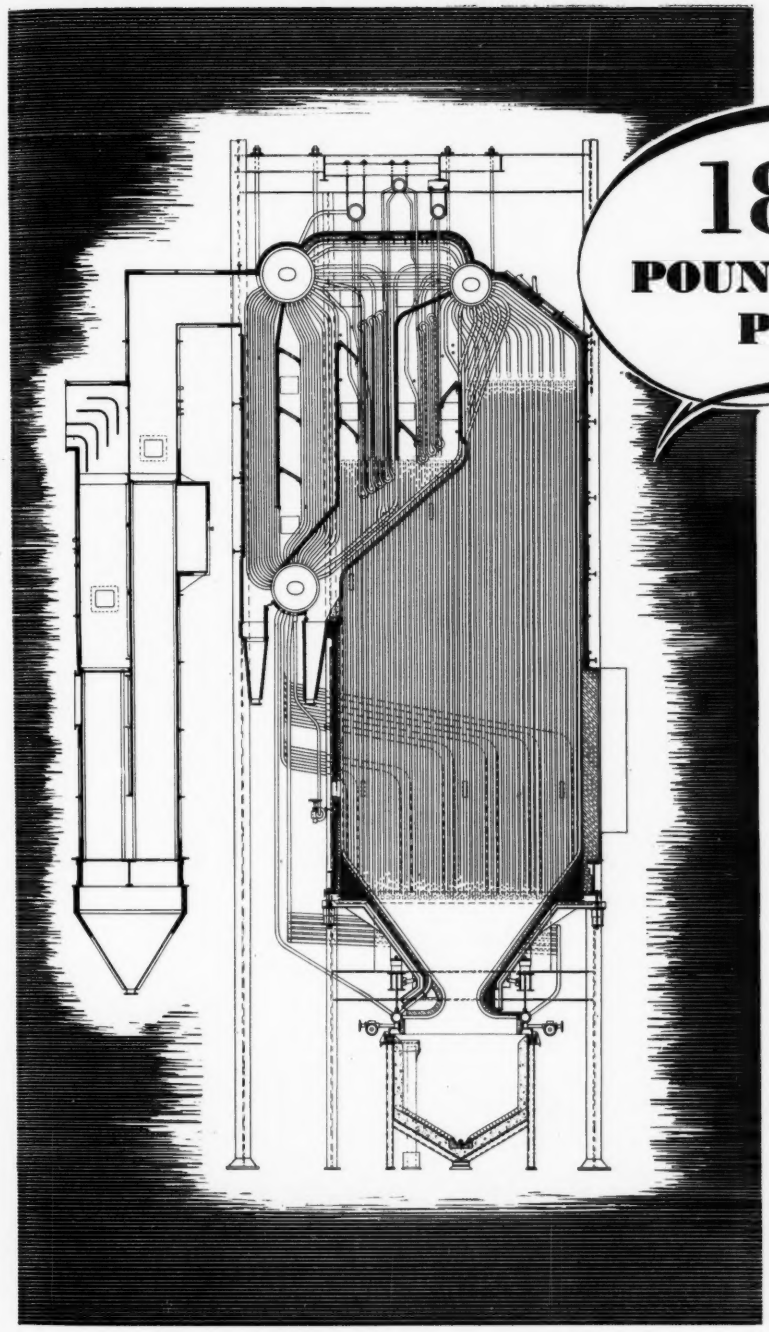
We are concerned here chiefly with plants that have been in operation over the years with a steady growth of production regardless of heat balance; the former fuel bill was not too high to make a good profit; but under present competitive conditions and mounting fuel costs, it is necessary to make a thorough survey of operating conditions.

In determining the quantities entering into a heat balance, actual measurement of these quantities, over a long enough period to establish average values of the major uses and demands of the various services in the plant, is essential.

Time Required for Survey

Time necessary to establish average firm figures for this analysis is a matter of experience and judgment. In a good many processes of a plant, the demand is quite constant and a measurement for two or three days will suffice to establish quantity and characteristics of the steam flow for a single process. In such cases one meter can be used for several such conditions, by moving the meter to other locations to secure the flows of other processes, which are known to have a steady flow characteristic and few peak demands. Other processes, which have wide fluctuations in steam demand, require a much longer check. Sometimes a survey of a plant may extend over a month's period. The following account of how such surveys are made is adapted from and based on data presented before the 1948 Midwest Power Conference.

First, it is essential to have or make a complete single-line diagram and layout of distribution lines, usually divided into low-pressure lines, high-pressure lines and electrical-distribution lines, as well as return lines, water lines, and the like.



185,000
POUNDS OF STEAM PER HOUR

Purchaser—
An Eastern Utility

Number of Steam Generators 4

Pounds of Steam/Hr. . 185,000

Design Pressure . . . . . 950 lbs.

Operating Pressure . . . 875 lbs.

Steam Temperature . . 885° F.

Heating Surface—
Erie City Boiler
13,300 Sq. Ft.
Erie City Water Walls
6,460 Sq. Ft.
Erie City Air Preheater
28,000 Sq. Ft.

Final Exit Gas Temp. . 328° F.

Method of Firing
Pulverized Coal

STEAM POWER PLANT EQUIPMENT

Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizer • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

ERIE CITY
SINCE 1840

ERIE CITY IRON WORKS • ERIE, PA.

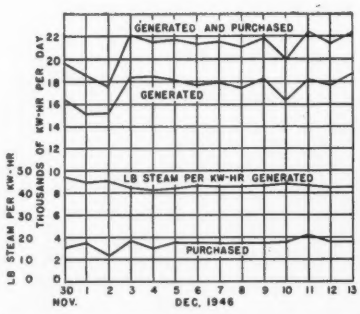


Fig. 3. Typical curves showing purchased and generated electricity and steam consumption for generated power. Such curves must be plotted for suitable periods corresponding to steam consumption data

Piping Diagrams Vital for Locating Meters

These piping diagrams are necessary for locating the meters. At each steam flow meter location, pressure gages are installed to determine pressure corrections for the flow meter. Calorimeter plugs are also installed for making moisture corrections. These are important, for it may be found that long lines have become overloaded and pressure loss is considerable; or, if velocities are below normal, wet steam will affect meter accuracy.

Figure 1 shows a single line diagram of a typical process plant studied in this way. Steam was measured at nine stations, as follows:

Station No.	*Location*
	Steam flow to:
1	Feed House.
2	Glue House.
3	Mill House.
4	Steep House.
5	Boiler Auxiliaries.
6	Dextrose House.
7	Starch Dryers.
8	Turbine.
9	Exhaust steam to atmosphere.

A similar line diagram, Fig. 2, shows the low pressure layout. Data collected on this system included: total return condensate; raw water make-up; condensed steam for heating; net boiler feed; steam to soot blowers (calculated); steam to air compressors and pumps; and per cent blow-down.

Meter charts were graduated in percentage, and the orifices designed to take peak demands at or below the 100 per cent chart limit.

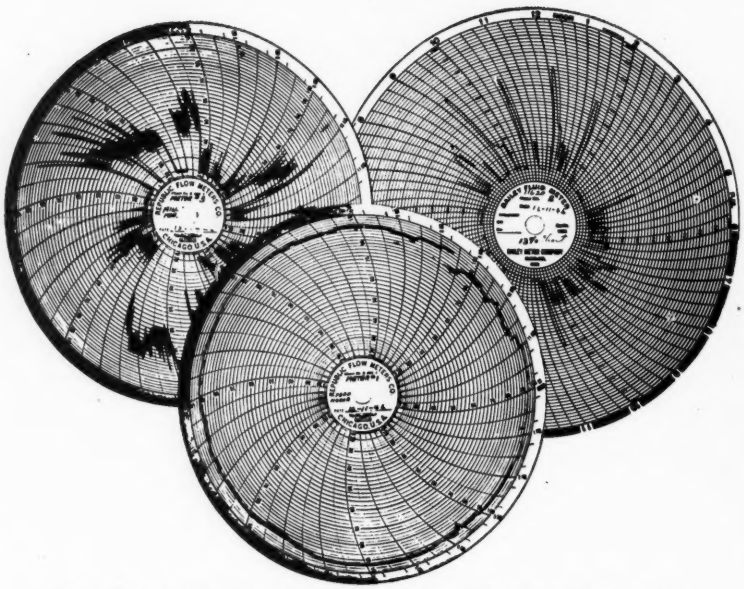


Fig. 4. Typical 24-hr charts of process steam demand for plant of Figs. 1 and 2

Determining Steam and Water Flow, Pressure, Temperature

The maximum flow was determined as closely as possible from experience of the process it supplied, and the orifice was designed for that location. Sometimes it is difficult to estimate the correct size of orifice, and it may be necessary to try more than one size. In order to avoid high expense for orifice plates, plain steel plate was employed, which is satisfactory for the survey period, but is not recommended for permanent use. Figure 4 shows typical 24-hr charts of process steam.

One of the most important measurements is the determination of make-up water to the steam generating plant. This was accomplished by installing a turbine water meter, calibrated over its full range and inserted in the make-up line. Proper installation of meters is the best measurement of condensate losses. Care must be exercised to ascertain that no overflows occur on heaters and softeners during the test period.

Temperatures of returns and make-up water were determined by frequent readings at the meters, utilizing portable recording thermometers at important locations.

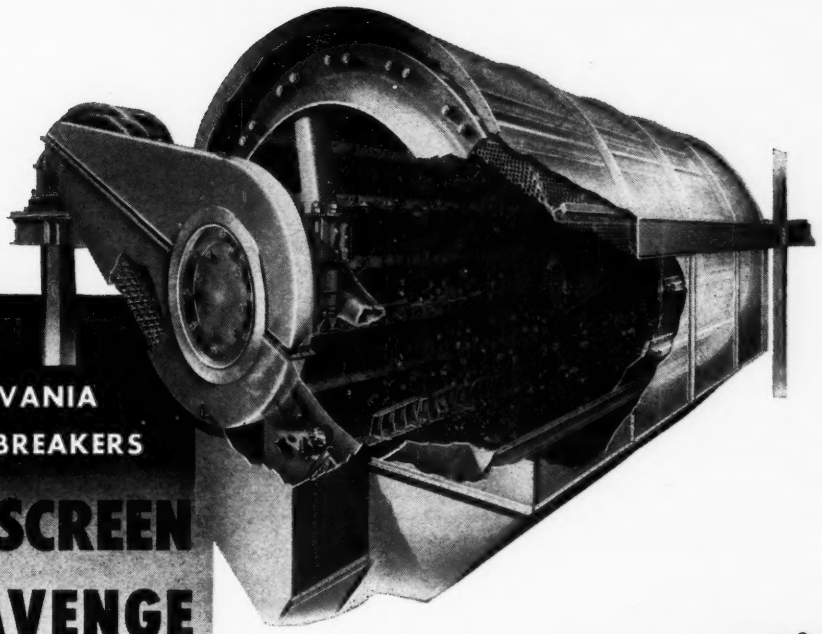
Avoidable losses occur, as well as unavoidable losses, and these must be determined. For instance, in the case of continuous blow-down system from the steam units, a means must be devised to check this loss throughout the period of tests, as well as the blow-down from a softener. In some processes, the steam is used

Table I. Table of high-pressure steam distribution quantities for plant of Figs. 1 and 2

Name	Total Per Day Pounds	Average Per Hour Pounds	Per Cent of Total Load Pounds	Pounds Pressure Gauge
Delivered to plant	1,734,250	72,250	100.00	142
Turbo generator	772,000	32,100	44.45	142
Feed house	430,000	17,950	24.85	100
P & S Starch dryers	248,000	10,330	14.30	140
Boiler room auxiliaries	79,200	3,300	4.56	148
Air compressor, pumps, etc. (calculated)	53,000	2,210	3.06	100
Mill & table house	44,250	1,845	2.56	100
Dextrine house	42,800	1,785	2.47	140
Steep house	41,700	1,740	2.41	100
Glue house	23,300	970	1.34	100

Table II. Table of process steam requirements for plant of Figs. 1 and 2

	Average Per Hour	Total Per Day
150 Lb. Steam		
Boiler house	3,300	79,000
Dextrine house Meter Station No. 6	1,785	42,800
P & S Dryers Meter Station No. 7	10,330	248,000
	15,415	369,800
100 Lb. Steam		
Feed house Meter Station No. 1	18,000	430,500
Glue house Meter Station No. 2	970	23,300
Mill & table house Meter Station No. 3	1,845	44,250
Steep house Meter Station No. 4	1,740	41,700
Air compressor, pumps, etc. (calculated)	2,230	53,500
	24,785	593,250
5 Lb. Steam		
Feedwater heater, space heating, low pressure process	35,000	840,000
Peak Demands—5 Lb. Steam		
Maximum Peak per hour	45,000	
Minimum low demand	20,000	



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More than 65% of all Pennsylvania Bradfords in central station service are single units (the multiple units are usually installed for capacity reasons).

This fact signifies the flexibility, scope and dependability of these units, and also indicates economy of investment and operation for the power plant. Because it is a dependable scavenger, the Pennsylvania Bradford protects stokers, pulverizers and conveyors from tramp iron and other mine refuse. It has the flexibility to handle rail, tidewater and storage coals—soft, medium and hard; wet, dry or frozen—from all sources, at all seasons of the year.

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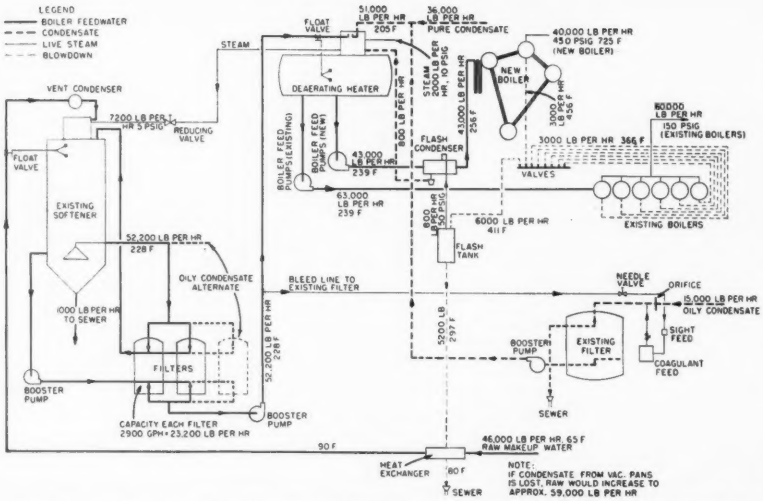


Fig. 5. Flow diagram of feedwater and blow-down system for remodeled power plant to serve Figs. 1 and 2

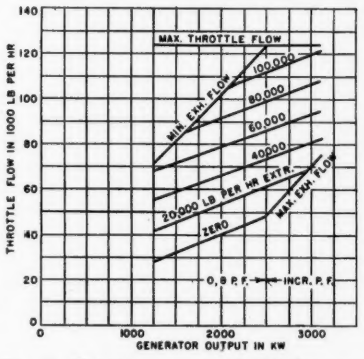


Fig. 7. Extraction curves of 2500-kw non-condensing extraction turbine

in direct contact in heating the product. In that event, the steam is measured by flow meter on the supply lines, but in a few cases the steam can be calculated quite accurately. Contaminated condensate being wasted is measured by meter on the condensate side. Careful investigation is made to determine how these wastes can be salvaged and returned to the system.

In the present case being studied, some processes were located in separate buildings producing a particular product and a measurement of the quantities entering the building established the values for this department. Recording charts show not only the total quantity used in a process but also show the characteristics of the flow, establishing peak and minimum demands. A study of these charts reveals undue peak demands that sometimes can be evened out by better scheduling of operation with their use. During such an investigation, careful daily records of production in each department is made by the plant operating force for proper correlation with demands of the various services supplied.

How to Collect and Arrange Data

The regular operating and maintenance crews can, under supervision and direction of the test engineer, insert all meters and instruments without seriously affecting operation, and the testing engineer can thus be assured that his data are correct and taken with proper care.

When installation of necessary instruments was complete, one test engineer was maintained throughout the period of the survey to make a daily log of all readings and compile

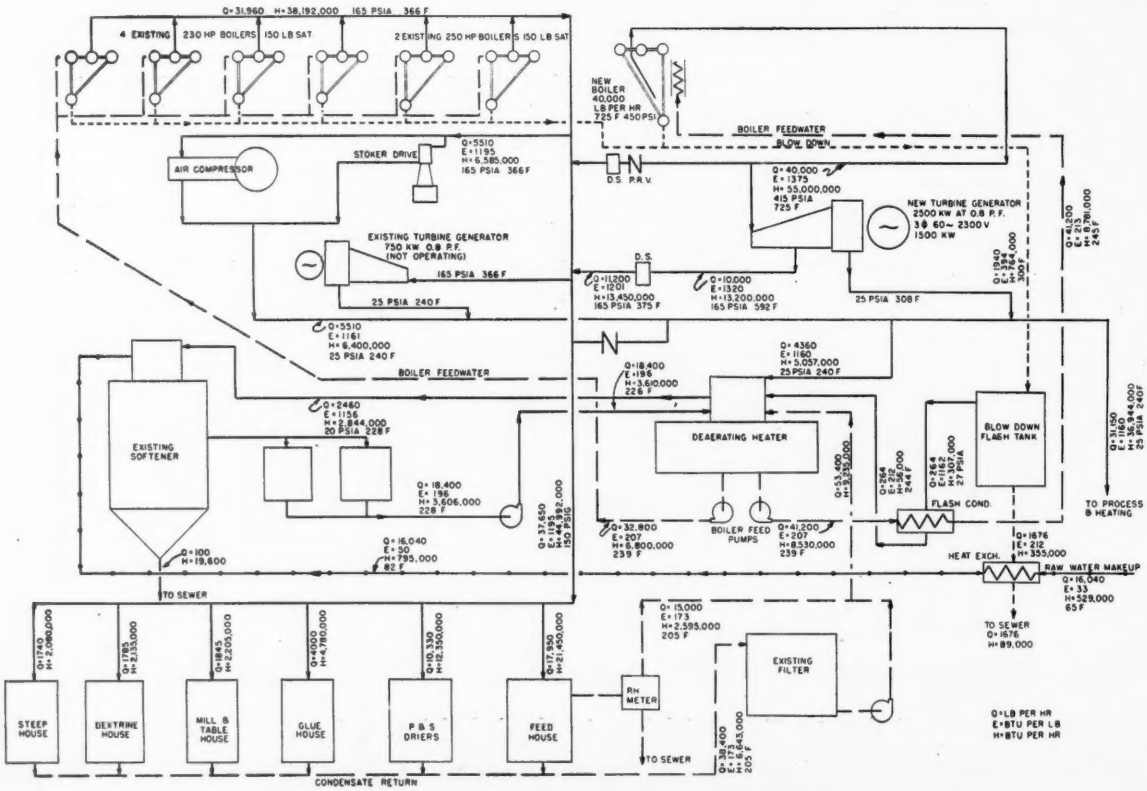
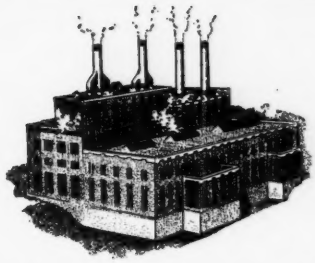


Fig. 6. Complete heat balance of plant with one new boiler

COCHRANE DEAERATORS AT CLIFFSIDE



The initial operation of the final unit of the Cliffside Station of the Duke Power Company, which brings the total output of this great generating station to 210,000 KW finds Cochrane Deaerators contributing to this project, as they have to the earlier units at Cliffside and to other Duke Power stations in the South.

Cochrane Deaerators are protecting the boilers, piping and turbines of the Duke stations listed below against rust and corrosion by removing excess oxygen and other corrosive gases from the feedwater, and aiding in their efficient operation by heating that feedwater to steam temperature.

Details of any of these installations or descriptive bulletin may be obtained by writing

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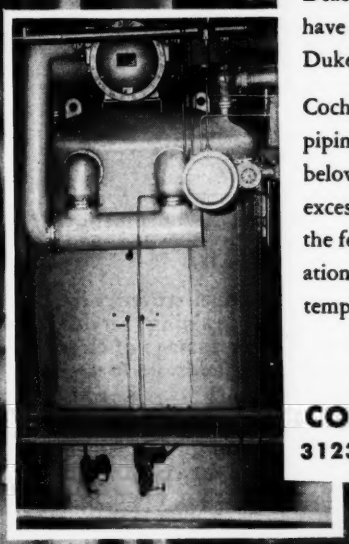

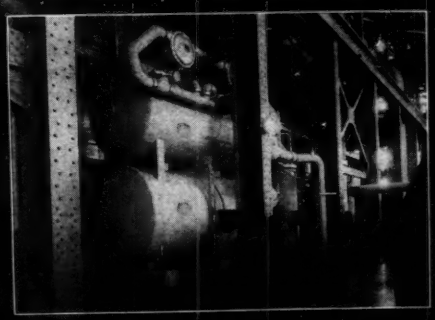

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Two 375,000 lb/hr Deaerators
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Two 8,000 lb/hr Open Heaters

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One 725,000 lb/hr Deaerator
Two 500,000 lb/hr Deaerators

TIGER
One 540,000 lb/hr Open Heater

MOUNT HOLLY
Two 270,000 lb/hr Open Heaters

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Two 650,000 lb/hr Deaerators

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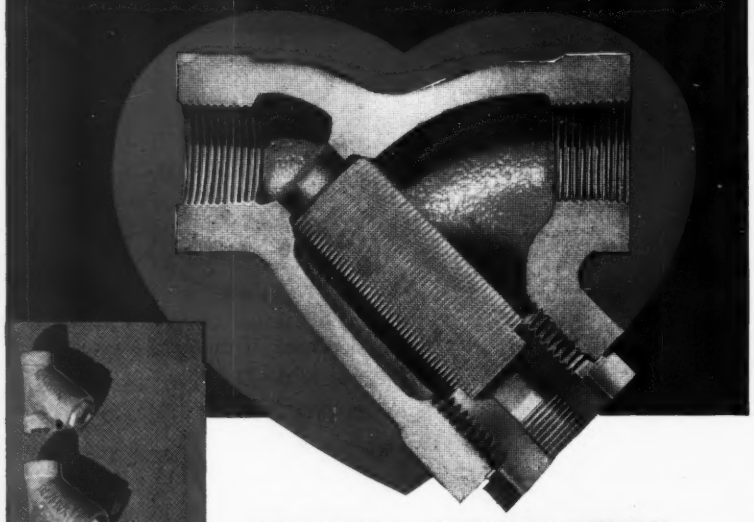
The SCREEN of the YARWAY STRAINER



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- *Screens* are of high-grade monel woven wire, fine enough for required straining service, yet having ample free area for passage of clean condensate, light oil or other fluids. Perforated screens if desired.
- *Screen cap* is made with straight thread, machined face and spark-plug-type gasket for attachment to body. Permits easy removal for cleaning. Insures proper alignment of screen when it is replaced in body.
- *Body* of Yarway Strainer is iron or steel, cadmium-plated for protection against corrosion and for better appearance.
- Available in six sizes, ½" to 2", for pressures to 600 lbs. Stocked and sold by 150 Mill Supply Houses. Reasonably priced.
- Hundreds of thousands in use. See your nearest dealer, or write for Bulletin S-201.

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114 MERMAID AVENUE PHILADELPHIA 18, PA.

YARWAY STRAINERS
"Police the Pipelines"

the records, properly figured and tabulated, and to check on all operations. In this manner, any discrepancies in records of instrumentation could be daily detected and corrected.

From these records, charts were made representing the quantities over the survey period, graphically showing the relation of electrical load to steam demand, and measured process use.

Tables I and II list the high-pressure steam distribution and the process steam requirements.

Study of a Starch Mill Power Plant

This plant was built originally as a starch mill, revamped 25 years ago by the installation of a non-condensing turbine, using large quantities of low-pressure steam, which gave a fair heat balance. In more recent years, the manufacturing processes have been changed; and, to speed production, high-pressure steam has been used in many instances where low-pressure was formerly employed. As the electrical load also increased, more and more exhaust steam was wasted and purchased power was resorted to, as well as that which was generated. This produced a poor heat balance, and this loss, coupled with the cost of purchased power, increased production costs to a point where the survey was necessary.

At the time of the survey, the six installed boilers, rated at 1420 hp at 150 psi and saturated steam temperature, were all in operation, heavily overloaded, found operating at low efficiency and with high maintenance and frequent interruption from outages. The 750-kw condensing turbine was examined and found to be operating at a high water rate due to blade erosion.

With the data accumulated, studies were made of the several possibilities, and several heat balances were made and evaluated to determine the most economical solution to meet present manufacturing schedules, provide for known increases, and a fair margin for future growth and expansion.

Details of New Equipment Selected

It was found that purchased power could be eliminated entirely, by selection of higher initial pressure and temperature for steam generation, using a single, automatic-extraction, non-condensing bleeder turbine.

Figure 7 shows the characteristics of the turbine finally selected.

Figure 5 shows a flow diagram with one new high pressure unit installed, along with the six existing units so arranged as to not interfere with the operation of the present set-up and the installation of the single bleeder non-condensing turbine.

In connection with the new unit, a deaerating heater was installed large enough to take care of the full future demand of the plant and a

(Continued on page 136)

Keeping stainless steel STAINLESS

. . . a typical problem in fabricating alloy piping

Heat a piece of stainless steel pipe to bend it and right away you're up to your ears in metallurgical complications. To begin with, stainless steel isn't just one alloy. There are hundreds of different types of stainless steel, each selected for its resistance to corrosion or its stability at high temperatures. To maintain the metallurgical properties which dictate the choice of a particular alloy steel, you have to know the temperature range within which this steel may suffer excessive metallurgical changes. And you have to have specialized equipment to maintain the precise control necessary to avoid these hazards.

Grinnell pipe fabrication equipment includes specially designed gas-fired radiant heat furnaces for this precisely controlled heat treatment of stainless steels and other alloy steels. Multiple burners are strategically located to distribute temperature uniformly and to prevent harmful flame impingement. Precision instruments regulate temperature and time.

It's an intricate business . . . fabricating alloy steel piping. It's a job for Grinnell prefabricating plants because Grinnell has the equipment and modern methods, the interpretive engineering, the metallurgical research facilities and the skilled personnel.

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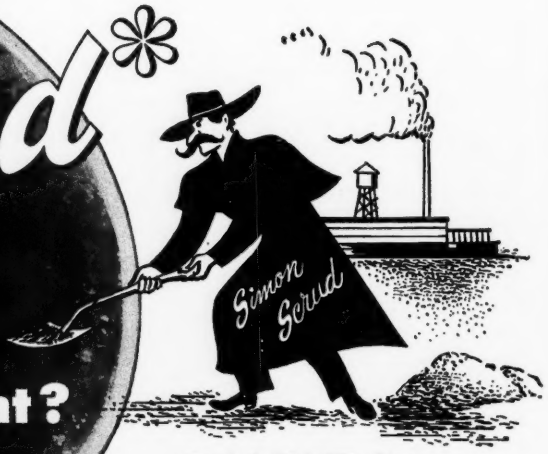
Is Scrud a problem in your plant?



* *Scrud: the SCale, RUst, Dirt, water, oil and other foreign matter in pipe lines.*

● **Scrud—a word coined to describe the damaging foreign matter nearly always present in pipe lines—can be eliminated completely. Staynew Pipe Line Filters are the answer.**

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...FOR AIR AND OTHER GASES

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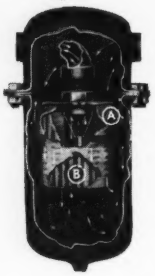
Swing Bolt Head

DOUBLE ACTION PRINCIPLE GUARANTEES BOTH CLEAN AND DRY AIR OR GAS

Model CPH
Bolted Head



Deflector Cup "A" directs air or gas to walls of housing, thence to base where heavier particles and liquids are deposited. Air or gas then rises thru Radial Fin Insert "B" where lighter particles are removed.

Models for high pressure; also high temperature or corrosive gases.

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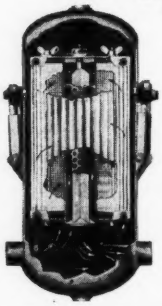

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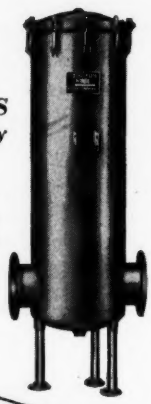
Small Capacity

Model ELS
Large Capacity



Wide variety of media available. Low first cost, also low maintenance due to Slip-On Insert which permits quick on-the-job change or replacement of medium. Models available for high temperature or corrosive liquids.

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★ **Large active filtering area in small space, thus low resistance to flow.**

★ **Inserts easily removed for cleaning or replacement.**

★ **Superior wearing quality.**

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Babu, the elephant's mahout, takes good care of his mobile power plant. After lugging logs and timber through the forest all day, his elephant gets a complete water treatment at the river. His feet are kept free of *scale* and *dirt*. He's rubbed and scrubbed . . . given the best of care because that's the best way to get work out of an elephant.

The best way to keep water and steam handling equipment at peak efficiency is with the aid of Bird-Archer water treatment. More than 60 years of experience lie behind Bird-Archer methods for combating scale and corrosion. The results in thousands of cases . . . lower operating costs, increased efficiency, longer equipment life.

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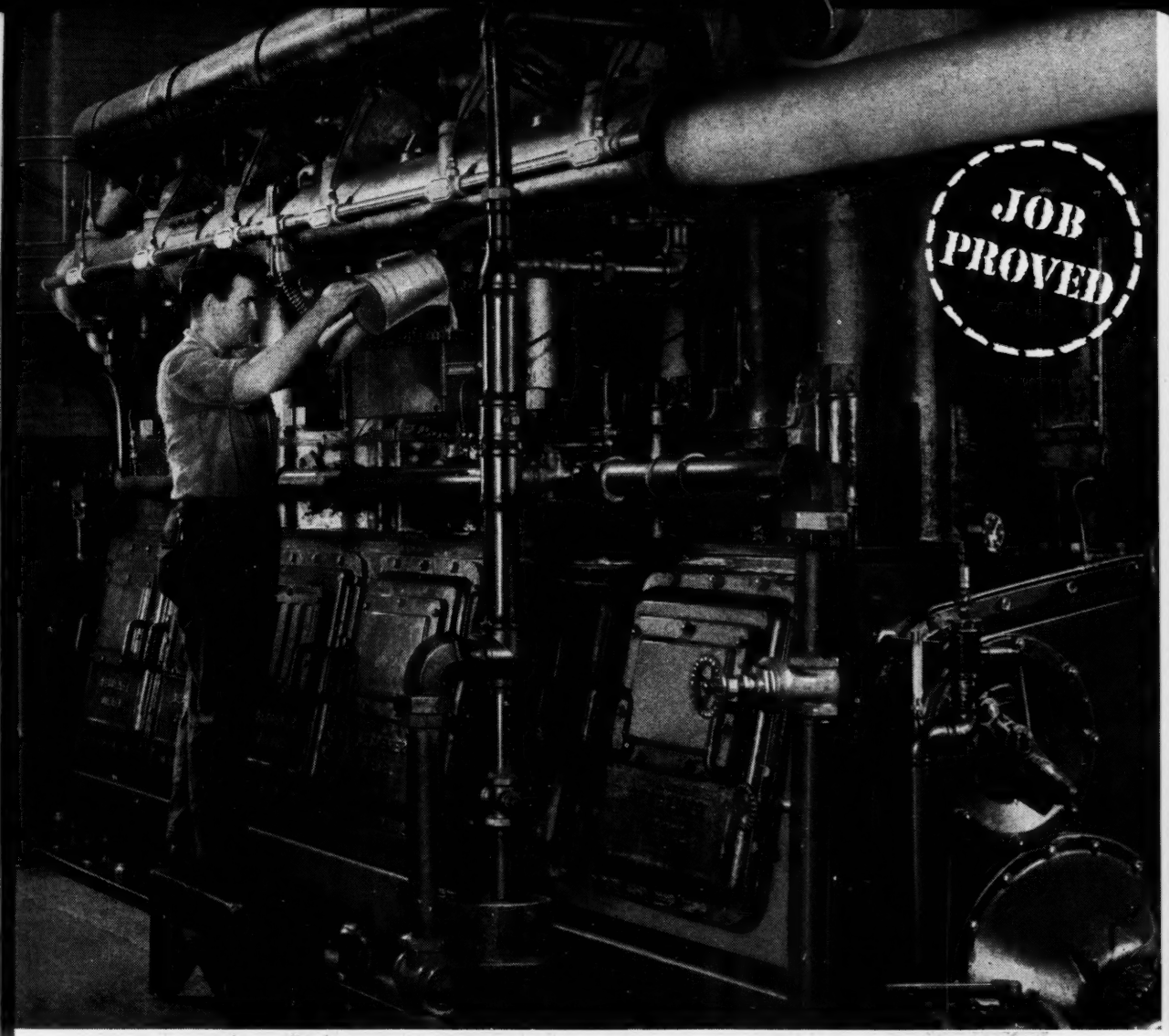

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Sun Diesel Lubricating Oil Almost Good As New After Outlasting a Competitive Product 5 to 1

A prominent manufacturer uses 6-cylinder, 4-cycle diesels to generate power. Recently, at the suggestion of one of our engineers, a Sun diesel lubricating oil was tried in one of the units.

Results were impressive. Inspected after three months, the engine was found to be in the cleanest condition since installed. In tests run against competitive oils, one manufacturer's product sludged up in 600 hours. Yet the Sun oil was practically as good as new after 3,000 hours, showing but a slight increase in neutralization number. In further tests, the Sun oil ran 4,200 hours in six months' operation without a change; the engine remained clean and sludge-free, and showed no signs of wear.

On the basis of this performance, the plant has extended the use of Sun oil to other diesel units.

Here is just one example of the records being set by Sun "Job Proved" lubricants in all their wide applications. You can rely on Sun products to keep diesels, turbines, steam engines and other power equipment operating smoothly and with minimum maintenance. To get complete information call the nearest Sun Office. For Technical Bulletin "Lubrication of Diesel Engines," write Department PN-3.

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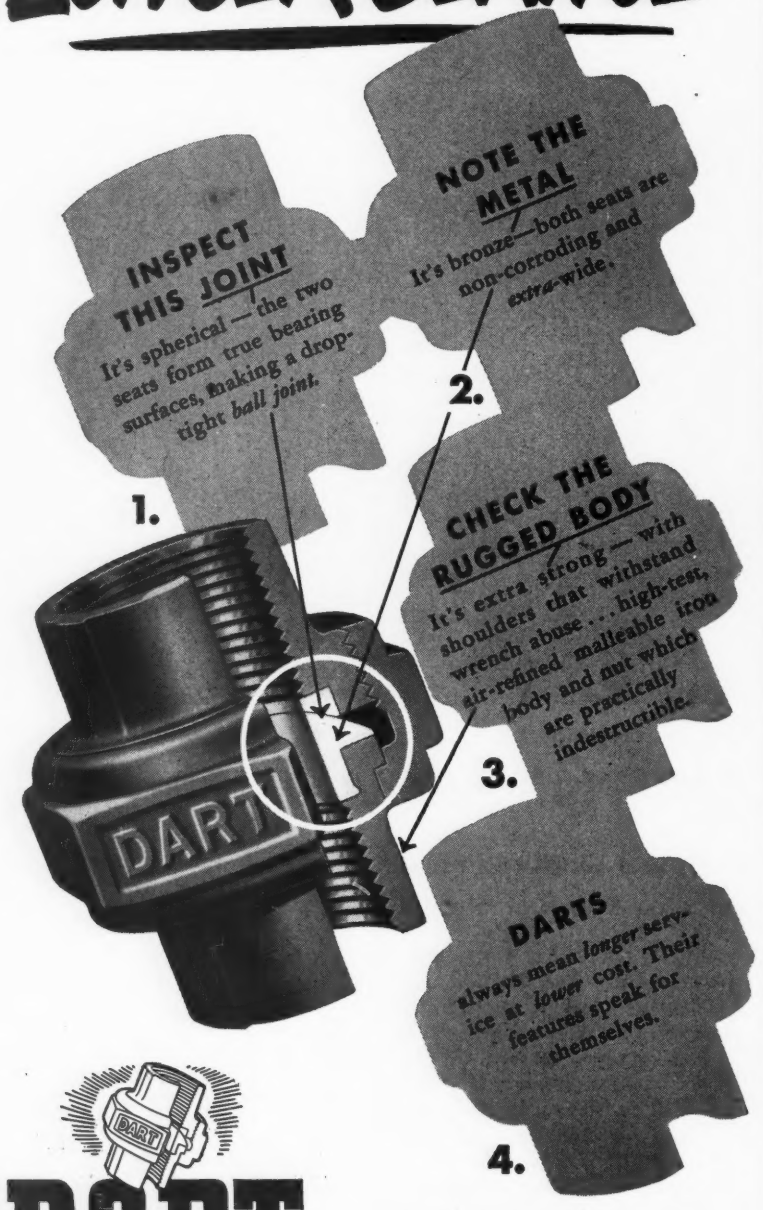
LONGER SERVICE


INSPECT THIS JOINT
It's spherical — the two seats form true bearing surfaces, making a drop-tight ball joint.
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NOTE THE METAL
It's bronze—both seats are non-corroding and extra-wide.
2.
CHECK THE RUGGED BODY
It's extra strong — with shoulders that withstand wrench abuse . . . high-test, air-refined malleable iron body and nut which are practically indestructible.
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DARTS
always mean longer service at lower cost. Their features speak for themselves.
4.
DART

DART UNIONS

E. M. DART MANUFACTURING CO.
PROVIDENCE 5, RHODE ISLAND

HANDLING COAL BY TRACTOR EQUIPMENT

(Continued from page 72)

tired equipment and the type drawn wholly by crawler-type tractors. Generally speaking, the rubber-tired equipment shows up best when the haul between the storage pile and the unloading and reclaiming point is long. It is, of course, impossible to fix any hard and fast breaking point where the shift from one type of equipment is in order. Working schedules involving idle time for the operators, the general size of the operation contemplated and similar factors—all must be taken into consideration in selecting the equipment for any given operation.

Some idea of the effect of the haul factor is given in Fig. 5, which shows normal performance for units of large size. As may be seen, the gain in time resulting from the high speed of the rubber-tired equipment over long hauls finally offsets the cost of the additional operator required for the pusher tractor. Where the haul is short, however, the gain in time becomes relatively unimportant when compared with the fixed time for loading and unloading, and the crawler-type equipment, with a single operator handling both the scraper and the tractor, shows the best economy. Manufacturers furnish tables and slide-rule-type computers, which this writer has found to be quite accurate in forecasting the output to be expected for any given situation and any combination of equipment.

Operating Experience

Union Electric Power Co. operates two plants in Illinois, each planned with large capacity coal storage facilities set up to handle coal either into or out of storage at maximum rates approximating 2,000 tons in 8 hr.

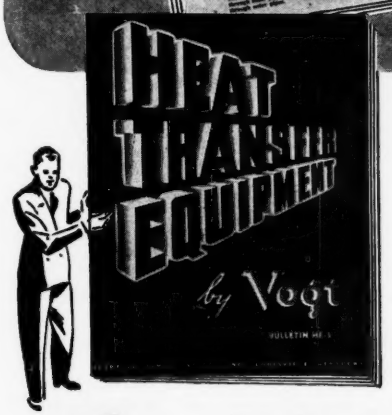
At Cahokia plant, the main storage pile, with a capacity of about 200,000 tons, is located close to the unloading and reclaiming point with an average haul between the coal pile and the unloading point or reclaiming hopper of about 300 ft one way. Storage operations at this plant are handled by three caterpillar D8 tractors. One of these is ordinarily used as a bulldozer; the other two are equipped with 14-cu-yd struck-capacity scrapers. The equipment is handled by three operators. The bulldozer serves to keep the pile trimmed and compacted, maintains roadways and cleans up generally. The scraper combinations haul the coal. It was estimated that the two scraper units could handle 750 tons each in 8 hr on the average haul and this has generally been realized. Actually, while reclaiming coal from that part of the pile nearer to the reclaiming point, outputs of 900 tons per 8-hr day have been attained.

There is a wide variation in the

Presenting

a pictorial record of standard and special built HEAT TRANSFER EQUIPMENT

by Vogt



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You are invited to send for this record of ingenuity in heat exchanger design and construction.

Shown, among examples of the many types we build, are units for diversified applications, high pressures, and special operating conditions as well as conventional types for ordinary exchanger services in petroleum refineries, chemical plants, process industries, power plants, etc.

Thousands of installations in successful operation attest to Vogt's ability to give effective help in the solution of heat transfer problems peculiar to a wide variety of operating conditions.

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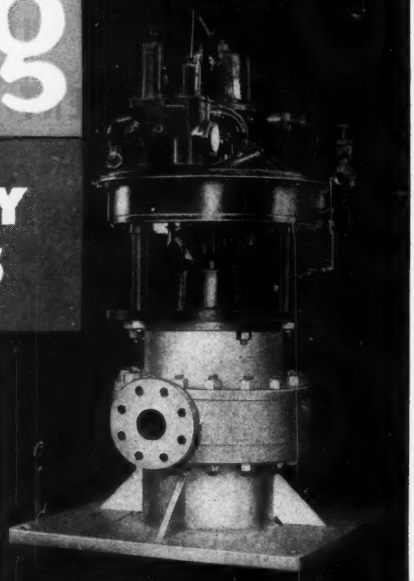
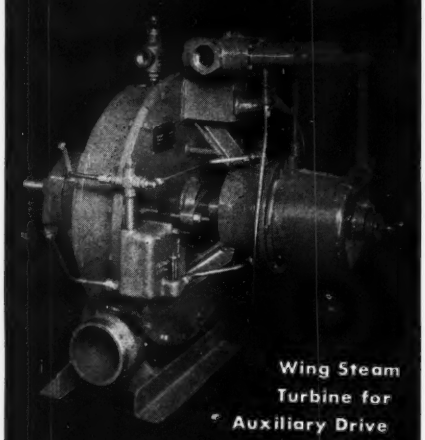
AUXILIARY TURBINES

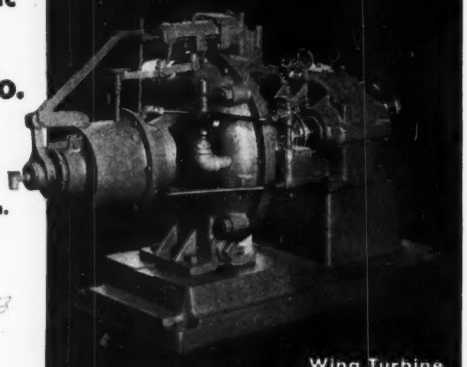
Wing All-Steel Welded Vertical Turbine for Pump Drive



Wing Steam Turbine for Auxiliary Drive



Wing Turbine and Gear Combination on common pedestal base



Wing Steam Turbines have been a dependable source of power in industrial and marine applications for over a third of a century. During that time these sturdy, dependable prime movers have been giving satisfactory service in thousands of industrial and marine installations under the most exacting conditions of service.

Wing turbines today are available for pressures up to 600 psi. and temperatures up to 750° F.

Write for turbine bulletin or for specific details.

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amount of coal to be moved each day. Cost figures, therefore, include a rather substantial amount of labor used at low efficiency. Over a year's operation, however, during which approximately 350,000 tons of coal were moved either in or out of storage, each move cost approximately 8 cents per ton, exclusive of unloading costs and capital costs of tractor equipment.

At the Venice plant, the limitations of the plant site dictated that the coal storage would be located at a considerable distance from the unloading and reclaiming point. Construction has not been completed, but some of the equipment has been assembled and it has been operated on a temporary basis sufficiently to indicate that the predicted performance will be realized. The average length of haul for storage coal at this plant will be 2500 ft one way. For this reason, considerable thought was given to the selection of equipment to be used. It was obvious from the start that crawler-tractor units such as those in use at Cahokia would be out of the question.

Design Characteristics and Effect of Coal

At this point, it is in order to digress for a moment and discuss the character of coal and its effect on the design of equipment to handle it. If it were possible to develop equipment specifically designed to handle coal, it is probable that it would differ considerably in its proportions from the type of equipment usually available. Manufacturers of equipment, however, find their principal market in the earth-handling industry where material, weighing about 1½ tons per cubic yard, is to be handled, whereas coal will average, when loosely piled in the scraper, only about ¾ of a ton per cubic yard. It should, therefore, be possible to handle very much larger volumes of coal than the usual tractor and scraper combinations are designed to handle.

One other factor, however, is that successful loading of coal in bottom-loading scrapers requires approximately the same tractive effort as that required for loading much heavier earth. It is, therefore, not possible to increase the volumetric capacity of the equipment if such increase in volume requires an increase in the cutting edge width of the scraper, unless it is definitely expected that push loading will be resorted to. For this reason, when a self-loading combination of a crawler tractor and scraper is being considered, the maximum size of the scraper that can be handled is substantially equal to the size which would be used in the same combination for earth, although the transported tonnage of coal would be substantially less than tonnage of earth moved.

None of the self-propelled units,

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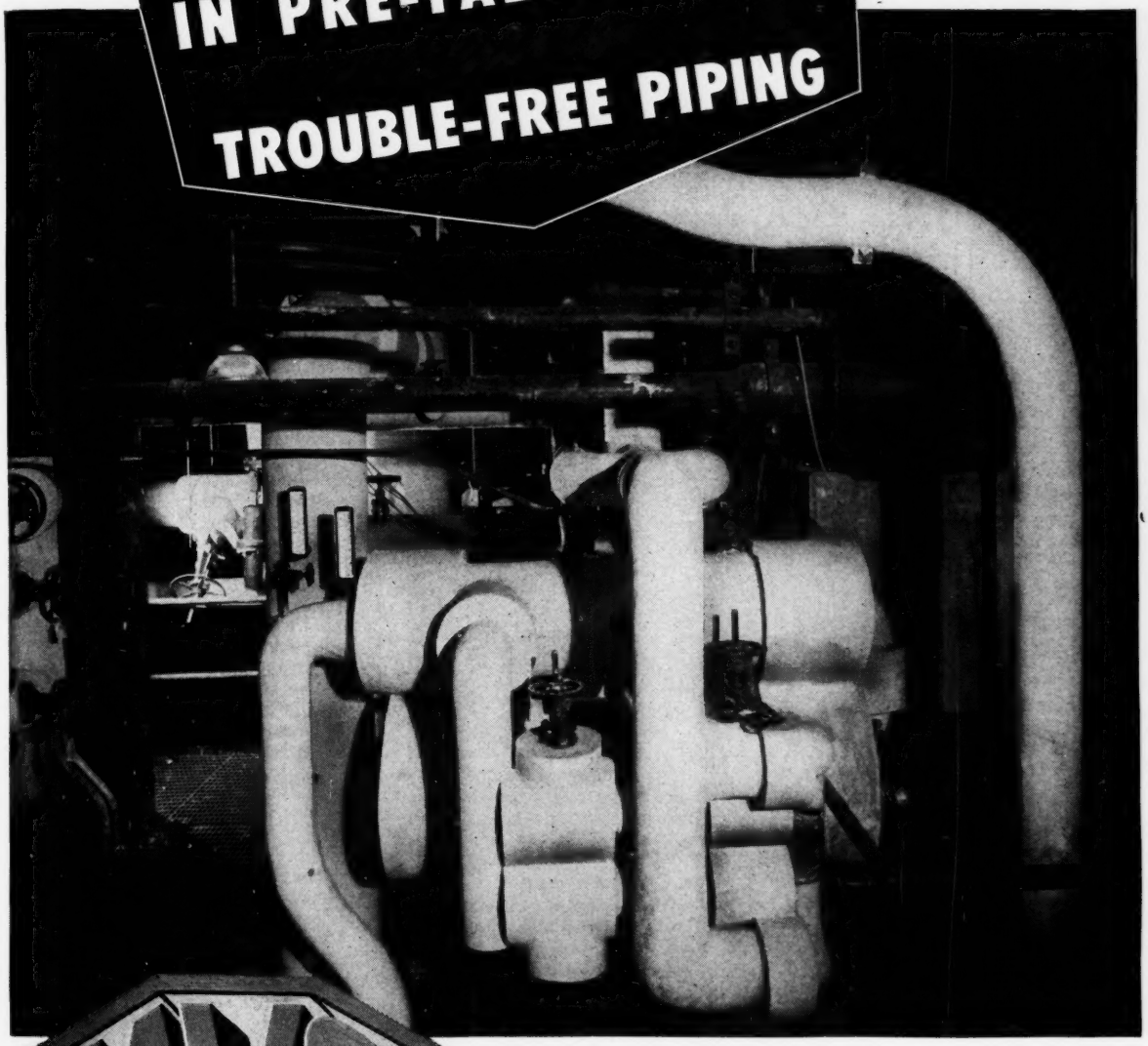

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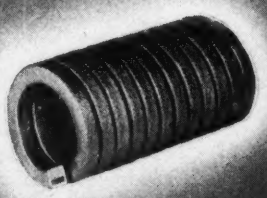

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all of which at the present time require push loading on either coal or earth, are so designed that the larger scraper, which would be advantageous in handling coal, can be attached to the corresponding tractor unit. The result of this is that self-propelled equipment cannot be worked on coal at its normal rated tonnage capacity. This means that the ratio of pay load to gross weight is low and the operation is inefficient, particularly on heavy grades.

The unbalance in the design of self-propelled equipment when used on coal was overcome by the local representative of one manufacturer, by adapting in his service shop a 14 cu-yd struck-capacity scraper to a four-wheeled rubber-tired tractor, eliminating the front wheels of the scraper, thereby converting the combination to a typical rubber-tired tractor and scraper unit. The combination is capable of performing entirely on coal at the designed tire loadings and has a capacity roughly 50 per cent larger than the normal scraper equipment supplied for the combination. The combination was available at approximately 75 per cent of the cost of the nearest competitive self-propelled unit, which was incapable of such adaptation having equal coal tonnage capacity. They had been giving entirely satisfactory performance, although the opportunity has not yet been developed to test them under sustained high loads.

It is expected ultimately to set the Venice storage operation up on the basis of 2,000 tons of coal in 8 hr. At the present time, equipment consists of two caterpillar D8 tractors with hydraulic bulldozers and two self-propelled rubber-tired tractor scraper units described above.

It is expected that each of the scraper units will deliver into storage or reclaim 760 tons of coal per 8-hr day. Preliminary performance of this equipment indicates that this can easily be realized. For the ultimate development, a third 14-yd unit will be needed. One tractor bulldozer unit is used for general purpose compacting coal, maintaining roadways, shaping the pile, and so on. The second tractor unit is used as a pusher when reclaiming coal from storage. The scrapers will be loaded from the top from an overhead bin when coal is to be placed in storage, so that no pusher will be required. This loading operation is shown in Fig. 6. Because of the additional operator required for the pusher, it is expected that the average cost of reclaiming coal from storage will be about 10 cents per ton whereas the cost of storing coal will be about the same as at Cahokia, 8 cents per ton with an average cost in or out of storage of 9 cents per ton per move.

All figures on costs are based on present labor rates and subject to change.

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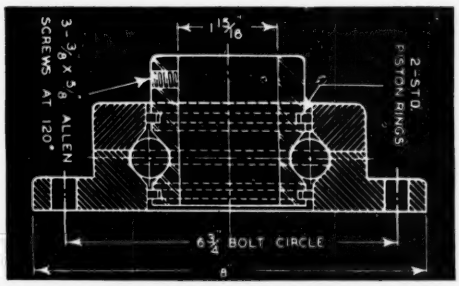

This drawing shows the simple construction of the Heacon bearing. Ample clearance is provided to accommodate expansion due to heat and misalignment. Metal ring seals on either side of ball races provide proven guard against dust leakage, yet permit free rotation.

One of the advantages of Heacon Dampers is that of low power, constant torque for operating the curtain shaft.

Heacon designed dust-proof bearings are largely responsible for the easy rotation of this spindle—they will also operate freely even if shaft is out of alignment. The inherent design of the damper relieves the operating shaft of strain due to gas flow or static pressure.

This dust-proof bearing is only one of many details in the design of a Heacon Damper that assures you satisfactory performance with a minimum maintenance for practically the lifetime of your equipment.

Heacon dust-proof bearings are available for other applications involving shaft operation in a dust concentrated atmosphere. For information write the project engineer nearest you.

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MAINTENANCE OF ELECTRONIC REGULATORS

(Continued from page 75)

ponents perform in the system. This step may be greatly facilitated by breaking up the entire regulating system into its basic functional parts. For a regulating system of the type into which many modern electronic voltage, speed, currents, etc., regulators fall, these parts frequently are:

1. A feedback and director (reference) mixer circuit for providing an error signal suitable for feeding into the amplifier.
2. An amplifier, usually a d-c amplifier, having a voltage gain dictated by the regulating accuracy desired.
3. A power-output stage consisting of either (a) a push-pull vacuum-tube power amplifier when a rotating amplifier is used as the final power element, or (b) a thyratron rectifier and phase-shifting circuit when the regulator is all-electronic.
4. A stabilizing (anti-hunting) circuit or circuits.
5. An auxiliary circuit or circuits, when required, for providing such miscellaneous functions as current limit, voltage limit, timed acceleration, IR drop compensation, etc.
6. A power and reference-voltage supply.

Fig. 3 shows how the voltage regulator of Fig. 2 may be broken down into its basic parts. Note that in this amplifier the stabilizing circuits (See Item 4, above) form an integral part of the amplifier, and that no auxiliary circuits (Item 5) are included. Because many different methods of stabilizing regulating systems are used, it may be difficult in some diagrams to identify components used for stability purposes unless one is well versed in the theory of servomechanisms. Auxiliary circuits often may be recognized by the identifying nomenclature used for associated adjusting rheostats and potentiometers.

Instruments

Unless the serviceman intends to service the regulators by the time-consuming method of replacing the components, one by one, until the equipment becomes operative, he will need some instruments to help him locate the source of the trouble.

The basic servicing instruments, aside from tube testers, which have been covered elsewhere, are just two: a multi-purpose meter, preferably a vacuum-tube volt-ohmmeter, and a suitable cathode-ray oscilloscope.

A multipurpose meter, as the name implies, is an instrument which can measure several different quantities, usually several ranges of d-c and a-c

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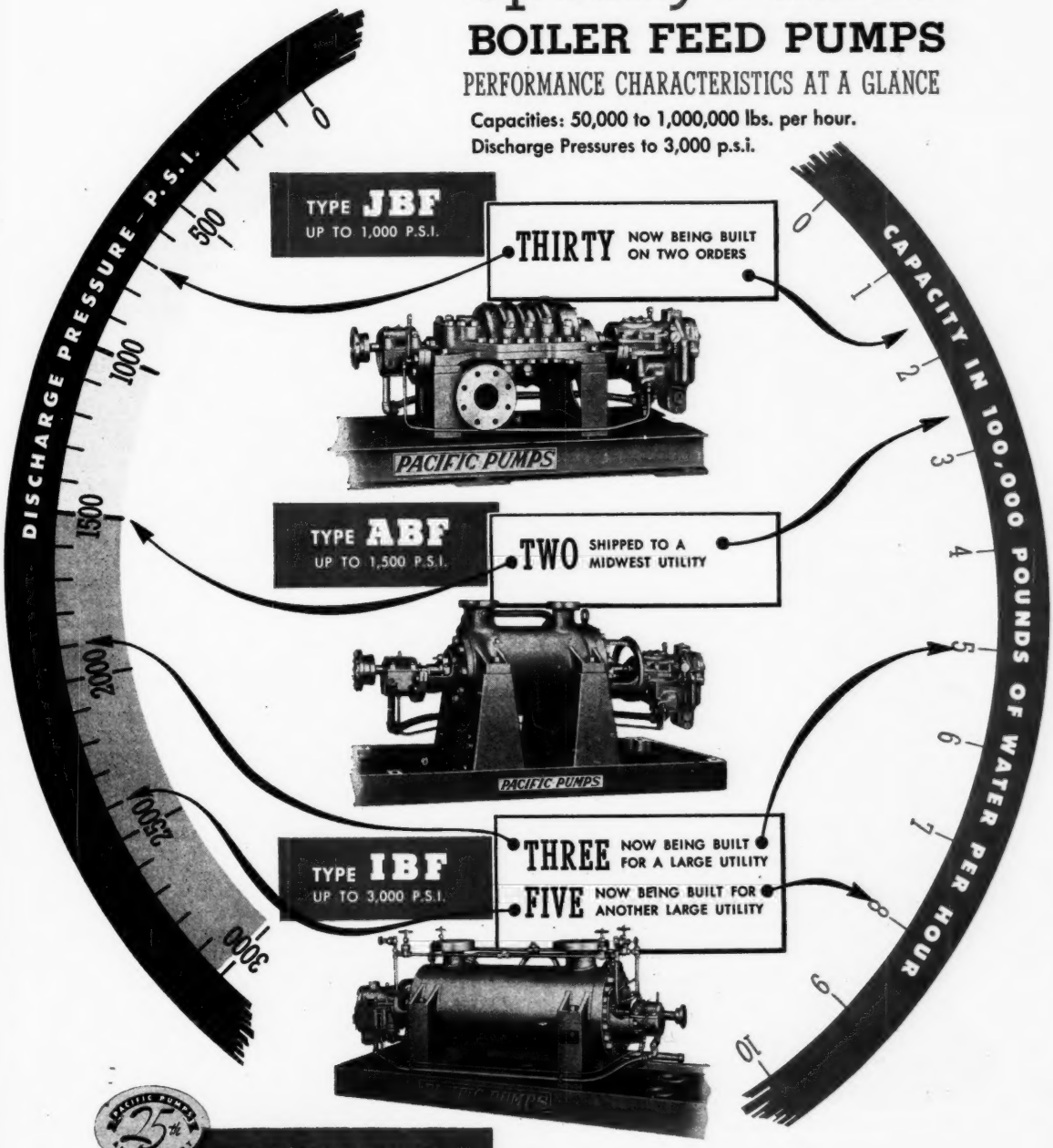

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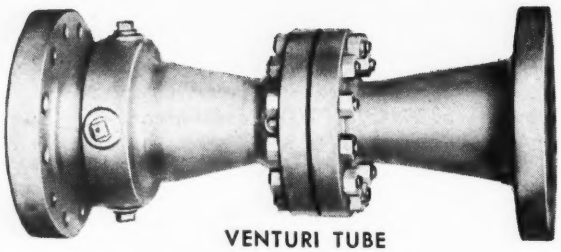

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Simplex Type MO Meters, when used in conjunction with Simplex Venturi Tubes as primary devices, guarantee the utmost accuracy in flow measurement over long ranges. They can be furnished to measure accurately over ranges of 20 to 1, 25 to 1, 28.5 to 1 or 32.5 to 1.

Where flow ranges are long, a single meter often will be sufficient where two or more ordinary instruments would otherwise be required.

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SIMPLEX

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voltage, numerous values of resistance, and sometimes d-c currents. The d-c voltage and the resistance scales of this instrument are the most useful.

It is essential that the instrument exhibit high resistance on the d-c voltage scales. This is necessary in order that the meter does not load up the high-impedance circuits found in most electronic regulators and give false indications of voltage as a result. Instruments having sensitivities lower than 20,000 ohms-per-volt (50 microamperes full scale) should not be used, and even these are not suitable for low-voltage measurements in high-impedance circuits. High-impedance a-c scales usually are not necessary.

Multi-purpose Meters

Two different types of multi-purpose meters of modern manufacture are suitable for checking electronic regulators. The first of these, an electronic instrument, is suitable for reading a-c and d-c voltages in scales ranging from three to 1000 volts and resistance values up to about 1000 megohms. Its input resistance is 11 megohms for d-c measurement. A-c voltage measurements are made non-electronically by means of a half-wave, dry-disc rectifier circuit having a sensitivity of 1000 ohms-per-volt. An internal dry-cell supplies current for resistance measurements. This instrument may be classified as semi-portable on the basis that it reaches a separate 110-volt supply for its operation.

The second type of multi-purpose meter is a self-contained unit having a 50-microampere instrument as the basic indicating means (20,000 ohms-per-volt sensitivity) and the necessary shunts, dry cell, rectifier, and multiplier resistors for adapting it to measure various values of d-c current, resistance, and d-c and a-c voltage. The voltage scales usually range up to about 1000 v, current scales up to about 10 amp, and resistance scales up to about 10 megohms. These are fully portable instruments requiring no external source of power.

Cathode Ray Oscilloscope

The second of the two basic servicing instruments is the cathode-ray oscilloscope, an instrument of great versatility and one which is virtually indispensable when servicing regulators containing thyratron circuits. This device actually draws a picture of the voltage being observed. It can be used to measure both d-c and a-c voltages of any waveshape by calibrating the instrument with voltages of known magnitude. When checking thyratron circuits, it is of inestimable value in determining the waveshape and the relative phase positions of various pertinent a-c voltages.

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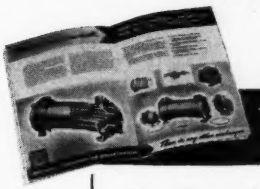

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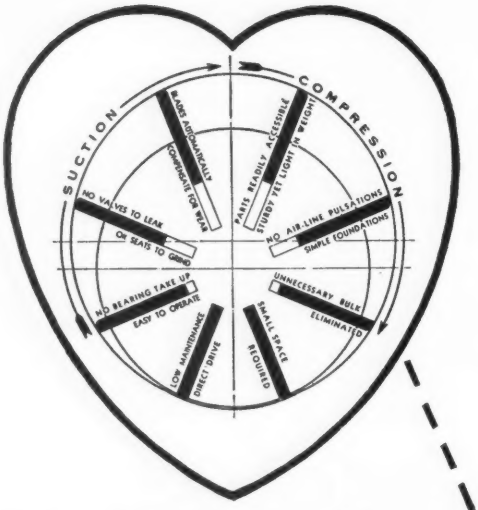
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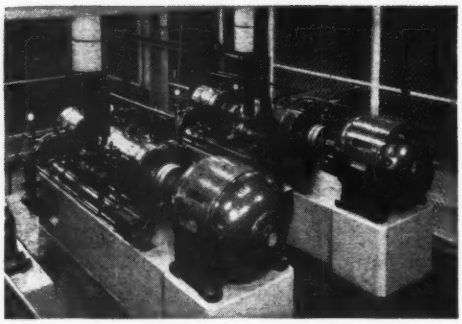

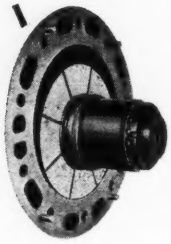

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C-182

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ode-ray oscilloscope are: (1) a cathode-ray tube; (2) vertical and horizontal amplifiers; (3) sweep circuits; (4) means for synchronizing the sweep with the voltage being observed, and (3) the necessary power supplies.

In order to be suitable for use in servicing most types of electronic regulators, the cathode-ray oscilloscope should be capable of indicating d-c voltages. While a great many makes and varieties of these instruments are available, only a very few types are thus equipped. Most types contain only a-c amplifiers, and will not respond properly to the d-c components of the voltages applied to their terminals. Fortunately, however, a few simple circuit changes will adapt most models for d-c deflection.

An excellent article which discusses the use of the cathode-ray oscilloscope in industrial applications and which describes how to change a standard unit for d-c deflection is listed among the references at the end of this article.

Spare Parts

Once the cause of regulator failure has been established, the next step is to repair the equipment. In this connection it is advisable to have on hand spare units of some of the more commonly used parts. Where the economics of the situation justify it and mechanical considerations permit, a complete spare regulator is desirable. In most cases, however, this is not feasible.

A complete set of spare tubes is a sound investment. While carbon and similar low-wattage resistors and potentiometers seldom give trouble, wirewound units occasionally become open-circuited and may require replacement. This is particularly true of the main adjusting potentiometers and rheostats, which normally get considerably more usage than the panel-mounted units provided for making initial adjustments. Wax capacitors sometimes deteriorate. The transformers used in regulators are subject to the same life expectancies that apply to any transformers.

In general, however, well designed electronic regulators utilize high-quality components that are conservatively rated. Unless a regulator is improperly applied or operated under very adverse conditions, it should provide years of trouble-free service.

References

"How to Install and Maintain Electronic Controls" (Parts 1 and 2) by H. L. Palmer. *Factory Management and Maintenance*, vol. 103, Nos. 11 and 12, Nov. and Dec., 1945.

"Industrial Electronic Control" by W. D. Cockrell. McGraw-Hill Book Co., Inc., 1944.

"Electronics in Industry" by G. M. Chute. McGraw-Hill Book Co., Inc., 1947.

"The Cathode Ray Oscilloscope—What It Is, How to Use It," by O. W. Livingston. *Electrical Contracting*, June, 1944.

"Electronic Control; Maintenance and Trouble-Shooting Tips," by W. D. Cockrell. *General Electric Review*, V. 46, Sept. 1943.

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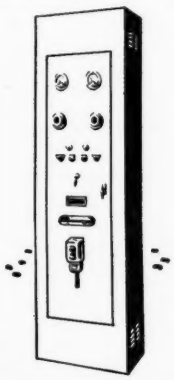
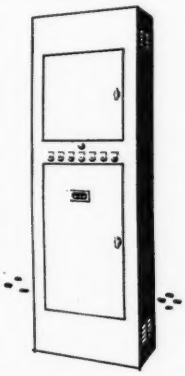
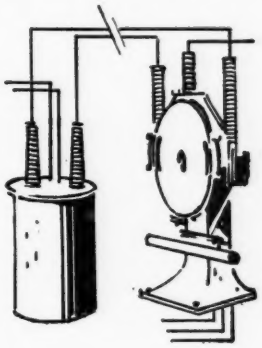


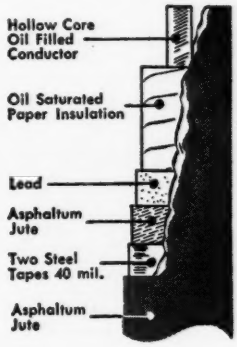
RECTIFIER SWITCHBOARDS—are of the Enclosed Cubicle type with flush-mounted meters, push buttons, selector switches, and indicating lights. The cabinet door and rectifier control circuit are interlocked. Rectifier and transformer contactors, instrument transformers, tap switches, terminal blocks and other auxiliaries are mounted inside the switchboard cabinet.



RAPPER AND POWER PANELS—are of the same external appearance as rectifier switchboards and can be installed beside rectifier switchboards to form a uniform and continuous switchboard installation. The cabinet is divided into two compartments—one containing AB breakers for control of all individual rectifier and signal circuits—the other containing all rapper controls and timers.



RECTIFIERS—for either full or half wave rectification. Mechanical rectifiers of the solid disc type are supplied with Radio Interference Correctors and Inductive Type Automatic Polarity devices. The Automatic polarity device has no commutator or brushes contacting high speed rotating parts. High voltage switch gear with interlocking control units is available.



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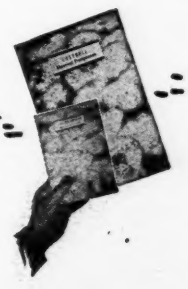

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REDUCING BOILER SLUDGE

(Continued from page 77)

the case of a water containing 15 ppm or 0.5 epm (equivalence per million) of silica and 24 ppm or 2.0 epm magnesium. For precipitation of the magnesium as serpentine the water should contain a minimum of 1.34 epm or 40 ppm of silica. However, base-exchange softening, with no provision for special silica removal procedure, which would be expensive with silica concentration of the magnitude indicated, will reduce magnesium to low concentration and the end result is a water containing an excessive amount of silica for use in high-pressure, high-rating boilers.

Use of Silicate in Hot-Process Softeners:—Magnesium removal with silica in a hot-process, lime-soda softener is similar in principle to silica removal with magnesium. The similarity does not end here; for, except in special cases that involve very high pressure, rating and/or heat absorption, and require very low silica concentration, the final effluents should be similar in silica to magnesium relationship. In other words, the same ultimate objective is approached from opposite directions. This is true because, in a case where silica reduction is involved, removal must not be carried too far, or else adherent magnesium phosphate or hydroxide can deposit in the boilers. Conversely, in a case where magnesium reduction is involved, silica concentration must not be increased too greatly, or else boiler water silica concentration will be excessive.

In those cases where hot-process equipment is to be used to reduce silica to extremely low concentration, special attention to removal of magnesium is essential. A possible procedure is subsequent hot-phosphate treatment in a separate softener. For maximum removal of silica and suitable removal of magnesium with the procedure described, the process must be carried out in two stages, as phosphate will interfere with silica removal under the conditions normally maintained.

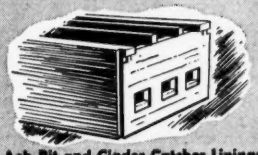
Silica naturally present in raw water is available for reduction of magnesium in the hot, relatively highly alkaline treated water. However, if magnesium is high in relation to silica then the naturally occurring silica must be supplemented with alkali-metal silicate. Although other silicates may be employed, the silicate compound normally used is water glass (sp. gr. 41°Be. — approximate alkali-silica ratio by wt. 1:3.2) because this is the cheapest source of silica.

Addition of the silicate is usually made to the chemical-mixing tank. Mixing with lime and soda ash in this manner undoubtedly results in precipitation of some calcium silicate but experience indicates that in the sedimentation tank the calcium sili-

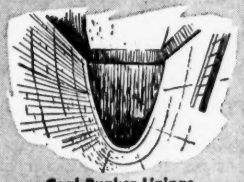
(Continued on page 129)

WHERE TO USE LUMNITE IN POWER PLANTS

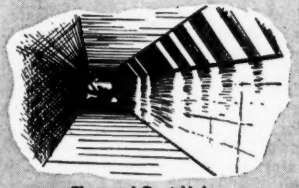
Steel Stack Linings



Ash Pit and Cinder Catcher Linings



Coal Bunker Linings



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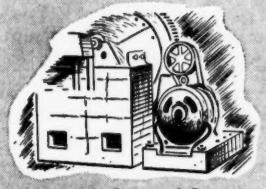

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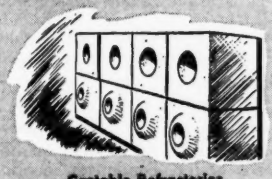

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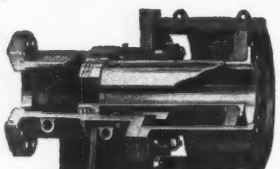

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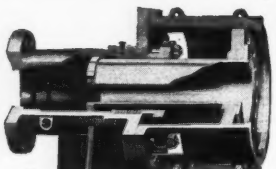

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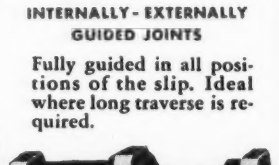

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POWER PLANT Construction News

Birmingham, Ala.—Alabama Power Co., 600 N. 18th St., plans extensions in steam-electric generating plant at Chickasaw, near Mobile, Ala., with installation of new 40,000-kw turbine-generator, and accessories. Also, will expand No. 2 steam-electric power plant at Gorgas, Ala.

Forrest City, Ark.—Arkansas Power & Light Co., Pine Bluff, Ark., will have plans prepared by Ebasco Services, Inc., 2 Rector St., New York, N. Y., consulting engineer, for proposed new steam-electric generating station at Forrest City, recently referred to in these columns. It is estimated to cost over $14,000,000, with turbine-generators, high-pressure boilers and auxiliary equipment.

Fowler, Calif.—International Ramie Co., Inc., Humboldt Bank Bldg., San Francisco, Calif., plans boiler plant at proposed new textile fibre mill at Fowler, where tract of about 30 acres of land has been secured. Mill will comprise several large production units. Entire project is reported to cost about $2,000,000. Work is scheduled to begin in spring. W. E. Clayton is president.

Canon City, Colo.—Southern Colorado Power Co., Pueblo, Colo., plans new steam-electric generating station at Canon City, with initial capacity of about 12,000-kw. Project will include switching station, extensions in transmission lines and other facilities. It is understood that work will be carried out this year.

Danbury, Conn.—State Bd. of Education, 249 High St., Hartford, Conn., plans extensions in boiler house for central-heating service at State Teachers' College, Danbury, reported to cost about $100,000 with equipment. Work will be carried out in connection with new buildings at institution, estimated to cost approximately $2,500,000.

Shreveport, La.—Bird & Son, Inc., Aero Dr., prepared roofing products, is reported planning boiler house for new felt mill, for felt base roofing materials, in Agurs district of city. Entire project will cost about $1,000,000. Rust Engineering Co., Clark Bldg., Pittsburgh, Pa., is engineer and contractor. Main offices of company are at East Walpole, Mass.

Dundalk, Md.—Consolidated Gas, Electric Light & Power Co., Lexington Bldg., Baltimore, Md., plans new generating station at Dundalk, reported to cost about $1,400,000, with equipment. Work will proceed at once.

Ilchester, Md.—Bartgis Brothers Co., paper boxes and containers, has plans for addition to boiler house, with installation of new boilers and auxiliary equipment. No estimate of cost announced. Work will begin soon. Westcott & Mapes, 109 Church St., New Haven, Conn., are engineers. Company is a subsidiary of New Haven Pulp & Board Co., New Haven.

Minneapolis, Minn.—Northern States Power Co., 15 S. 5th St., has plans for additions to generating station on Marshall St., N.E., for expansion in electric and steam departments, with installation of additional equipment. A new precipitator building, about 75 x 100 ft, will be built. Cost reported close to $1,500,000. Work scheduled to begin soon.

Lincoln, Neb.—Loup River Public Power District, Columbus, Neb., has approved plans for new generating station at Lincoln, on site at Ninth and K Sts. It will be 75 x 100 ft, equivalent to five stories in height. Installation will include turbine-generator, high-pressure boiler, condenser, cooling tower and auxiliary equipment. Cost estimated about $3,000,000. Erection will begin in March.

Bayonne, N. J.—Standard Oil Co. of N. J. has plans for new boiler house at local oil refinery. No estimate of cost announced. Award has been made for structural steel framing and work will begin soon. Day & Zimmerman, Inc., Packard Bldg., Philadelphia, Pa., is consulting engineer. Main offices of company are at 26 Broadway, New York, N. Y.

Clifton, N. J.—Yardley of London, Inc., 620 Fifth Ave., New York, N. Y., cosmetics, soaps, perfumery, etc., plans boiler house at proposed new plant at Clifton, where site has been purchased. Main factory will approximate 200,000 sq ft floor space. Entire project is reported to cost about $1,500,000. Work is scheduled to begin in June.

Weehawken, N. J.—Neo Gravure Printing Co., 601 W. 26th St., New York, N. Y., plans boiler house at new printing and publishing plant at Weehawken. Main building will be one- and two-story, about 315 x 500 ft. Entire project will represent a reported investment of $1,400,000. S. E. Berkenbilt and Walter DeCherrie, 82 W. Washington St., Chicago, Ill., are architects and engineers.

cate is decomposed, the calcium going to carbonate and the silica going to magnesium. The feeding procedure used has produced no difficulty whatever in the large majority of applications but in two or three instances the rate of formation of deposits in chemical pumps and lines has increased. As yet, there is no good explanation for this, as the deposits formed have been mainly calcium carbonate and have been very low in silica.

In dealing with waters high in magnesium requiring relatively large amounts of silicate in the softeners it would seem that the most economical procedure might be to remove as much of the magnesium as possible as the hydroxide in the softeners and then to use in the boilers only enough silicate to take care of the small amount of magnesium present in the treated and filtered waters. There is nothing wrong with this method of operation as far as the boilers are concerned; but magnesium hydroxide can form adherent deposits in sedimentation tanks, piping and filters. Therefore, improved softener operation both mechanically and chemically (lower magnesium concentration in treated waters), and greater cleanliness of filters usually justifies the expense of using the larger quantities of silicate. As a matter of fact, there are plants using silicate primarily for improvement of filter operation.

Suspended material in the raw water plays an important role in the application of silicate treatment to hot-process softeners. Suspended silica or aluminum silicate is dissolved in part by the hot, relatively highly alkaline treated water and significant amounts of suspended matter can badly upset silica control and result in excessive boiler-water silica concentration. Aluminum dissolved from aluminum silicate also goes on to the boilers in the treated water. It is desirable therefore, in practically all cases, and essential in those involving high pressure and high heat absorption, to remove suspended matter from water by filtration (or coagulation and filtration) before introducing it to a hot-process softener.

As would be expected, silica is not as effective in removing magnesium in cold-process softeners as when heat is applied. Also, the silica naturally present in the raw water is not available to the magnesium. Thus the process is not efficient even though it does not present the same problem of silica and aluminum pickup from suspended matter as does the hot-process.

(To be continued)

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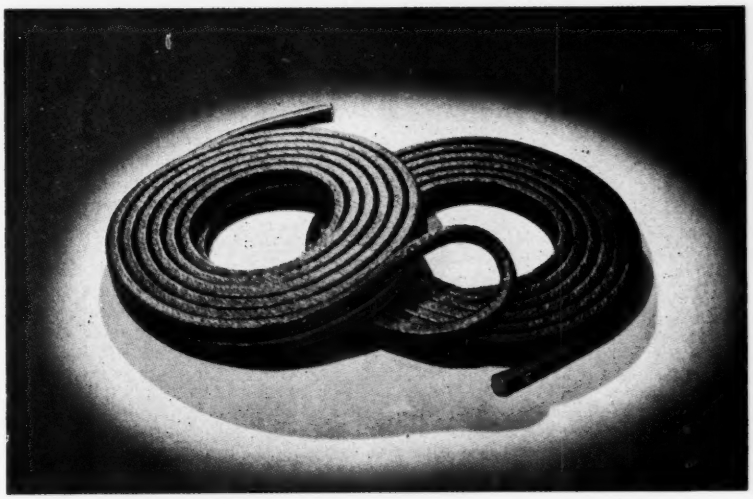

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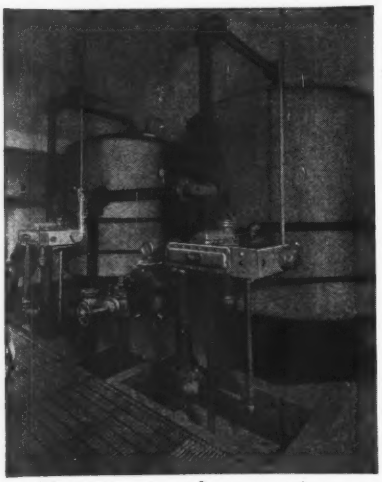

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PROCESSES FOR REMOVAL OF WATER IMPURITIES

PORT WASHINGTON

(Continued from page 69)

psig design and 1335 psig operating.

Extraction heaters are longer, affording lesser terminal temperature differences. The condenser is of different design.

General design of this newest unit follows the essentially satisfactory plan of the previous two. Figure 1 shows the flow diagram of Unit No. 1, which applies closely for No. 3. Addition of a reheater-steam "dump" valve, which by-passes 80 per cent of the 725 lb of full-load reheater-system steam directly to the condenser, is the principal difference.

Port Washington 3 Starting Experiences in 1948

September 26:—Initial starting attempt was delayed because turbine oil drained to the emergency tank when the oil pump started. Suspected leakage of the emergency-drain valve caused delay until an oil cooler drain cock was found inadvertently opened.

September 27:—Intercepting valves did not open and close properly, requiring inspection and minor changes.

September 29:—Turning-gear reduction-gear bearing seized. Its clearance was increased.

October 2:—Reached 1800 rpm. Governor spring adjustment found wrong.

October 3:—When at 1800 rpm, the governor-spindle bushing seized, causing a low-pressure oil-vapor "puff" in No. 1 bearing housing. Its clearance was increased.

October 5:—Tested safety governor, and synchronized.

October 6:—40,000 kw carried.

October 7:—Stopped for generator-fan inlet modifications, because one of the two axial-flow fans was inoperative. Bearing 6 and its journal were found scratched by foreign steel patricles, and all bearings were examined and re-conditioned.

October 12:—Resumed operation.

October 13:—50,000 kw maximum.

October 17:—80,000 kw maximum; started regular operation.

October 28-31:—Turbine inlet valve sticking corrected.

December 29:—In continuous service to this date, normally at 80,000 kw from 6:00 a.m. to midnight, except Sundays.

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4. Development of a Major Principle in Pul-

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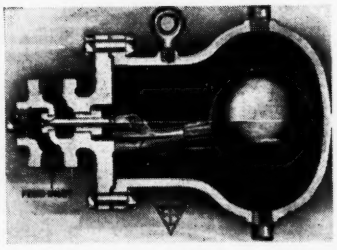

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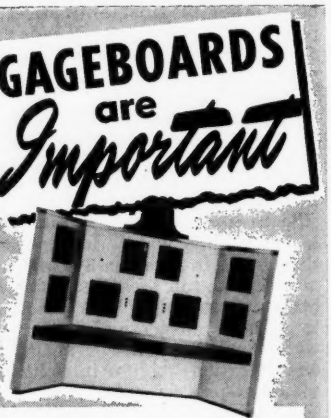

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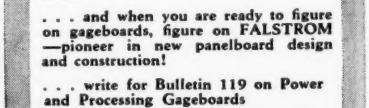

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DOW INSTALLS FIRST INDUSTRIAL CYCLONE BURNER

(Continued from page 81)

for the conditioners; two blowers are provided with one standby.

Each feeder is driven by a Reliance type P, 7.5-hp, d-c, 440 to 1600-rpm motor, through a Maxitorq clutch, an Ohio Gear speed reducer, 20-to-1 ratio, and a Link-Belt Co. chain drive.

Feedwater Supply

Feedwater for Boiler No. 13 will be either hot condensate from No. 12 existing softener deaerating heater or cold demineralized water pumped from the water treating plant to an outside storage plant near the West Side plant. Under suitable automatic control, the boiler feedwater will be supplied to a new Cochrane feedwater deaerator provided for deaeration of the demineralized water for Boiler No. 13.

From this deaerating heater, a single steam-turbine-driven boiler feed pump will pump feedwater to the No. 13 boiler. This pump is a DeLaval Steam Turbine Co. unit rated at 1200 gpm capacity, 3825 ft TDH, driven by a DeLaval 1520 hp steam turbine taking 400 psi throttle steam. It is equipped with a Republic Flow Meters Co. excess pressure regulator, which will operate the steam turbine governor valves to adjust the pump speed to maintain 60 psi pressure drop across the feedwater regulator.

Feedwater level in this unit will be controlled by a Copes relay-operating-type feedwater regulator, positioned by an air loading from a Type R thermostat and an integral steam flow element and pilot.

General Boiler Arrangement

General arrangement of the various parts of the boiler is easily seen on Fig. 7.

The superheaters are the continuous-tube draining type as shown, divided into two sections, the primary and the secondary. Steam passes through the primary section to a header, then to a submerged attemperator, for controlling steam temperature, located in the lower drum, thence to the secondary or rear section of the superheater.

The air heater is a Babcock & Wilcox welded-element air heater divided into three sections, primary, secondary, and tertiary. The economizer is a continuous-tube parallel and counterflow type divided into primary and secondary sections located as shown in Fig. 7. Figure 11, A, B and C, graphically indicates the circulation in the steam generating unit. Feedwater enters the primary economizer through a 6-in. feed connection.

The boiler has a complete Diamond Power Specialty Corp. sequentially-operated automatically-controlled air soot blower system. This operates on 250 psi compressed air, while 35 to 80 psi air is used to control and operate the soot blower units. Control is from a centrally-located program panel. The blowing program is normally scheduled to operate in sequence with relation to the flow of boiler gases, but any unit or group of units can be blown at a given time depending on the need for cleaning. Because the boiler will be operating under positive pressure, each wall box is purged automatically by a puff of air before the corresponding head can operate. Air for soot blowing is supplied by 2 Worthington 890-cfm air compressors.

Main steam and feedwater piping and valves were supplied by Crane Co.; high-pressure piping by Pittsburgh Piping & Equipment Co.

A Republic Flow Meters Co. pressure-reducing and desuperheating station is connected between the 1250 psi header and 400 psi systems, where the temperature is approximately 700 F. This station is de-

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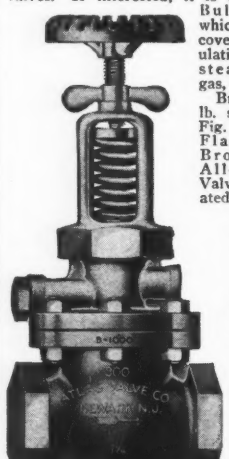
Several pages of this journal would be required to tell all about ATLAS Type "B" valves. If interested, it is best to ask for Bulletin No. 1-A which, in 52 pages, covers ATLAS Regulating Valves—for steam, water, air, gas, or oil.



Briefly, for 250-lb. service we offer Fig. 114—Iron Body Flanged Ends — Bronze or Nickel Alloy Seats and Valves—Pilot Operated—2½", 3", 4", 5", 6", 8". For 300-lb. service we offer the valve shown here — All Bronze — Screwed or Flanged Ends — Bronze or Nickel Alloy Seats and Valves — Pilot Operated, ¼", ¾", 1", 1¼", 1½", 2". For 400 and 600-lb. service and for other ATLAS Type "B" Valves, Bulletin 1-A gives all the details. Ask for a copy.

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signed to pass 700,000 lb of steam per hr and reduce it from 1250-psi, 900 F to 400 psi, 700 F, all under full automatic control.

The control system for the cyclone burner boiler is centralized on a boiler control panel designed by the Dow engineers working with Bailey Meter Co. which supplied most of the boiler control equipment. A separate water conditioning panel is provided, in conjunction with the boiler control panel, for measuring the water and steam conductivity, pH, and other factors.

The Bailey pneumatic combustion control system is arranged to maintain automatically the boiler outlet steam pressure (by operating coal feeder speed control), pressure in the forced-draft ducts leading to the cyclone furnaces, and the oxygen content of the gas in the furnaces within predetermined limits. The air loading to each coal feeder speed or duct damper control drive, transmitted from the master steam pressure controller, is corrected first by the steam-flow-air-flow controller and second by a per-cent-oxygen controller.

The boiler is equipped with one standard Diamond Power Specialty water column with the light beam transmitted to the operating floor, and equipped with a high-low level alarm. On the control panel is a Bailey dial type water level indicator, connected mechanically to a drum water level recording element of the water flow recorder. The Copes feedwater regulator may be controlled manually or automatically from the control panel. An Eye-Hye indicator and a high-low alarm are provided for the feedwater deaerator, also controls for the DeLaval feedwater pump, the demineralized water storage and the forwarding pump, and for burner ignition.

For steam temperature control, attemperator valves are automatically controlled from the superheater outlet header temperature by means of a temperature controller, modified by an air loading from the steam-flow controller.

Bailey steam flow indicators and recorders are provided for various functions, also Bailey draft gages and Micromax (Leeds & Northrup) temperature recorders for various air, gas and water temperatures.

Acknowledgments

For information contained in this article and for the opportunity to inspect the new No. 13 boiler in detail, this writer is deeply indebted to Merle Newkirk, manager of the Power Division of Dow Chemical Co. and to M. E. Brines, assistant superintendent of control; D. F. Steinke, engineer in the Power Educational Department; M. F. Ginter, assistant to manager; L. F. Wirth, assistant superintendent of control — all of Dow Chemical Co.'s Power Division. L. L. Moran is superintendent of power.

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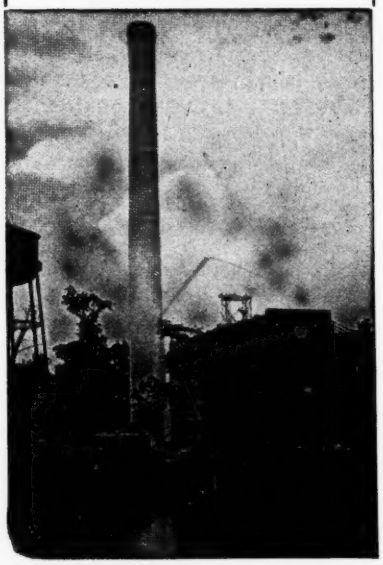

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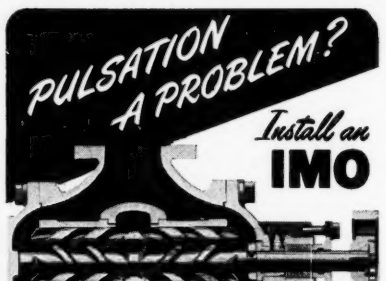

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WHAT'S NEW IN THE ELECTRICAL ART

(Continued from page 85)

and touches a fiber of another cell, it may, or may not, "fire" that cell, too. This selective action is the basis of the brain's operation.

The neurons are only one-thousandth as fast as vacuum-tube relays, but they require much less space and much less power. Dr. McCulloch pointed out that if an electrical computing machine had *only* 10 million vacuum tubes (the brain has 10 *billion* neurons), it would take the power of Niagara Falls to operate it and the water of the Niagara River to cool it. The brain is cooled by a comparatively small river of blood. When awake and in full operation, it raises the temperature of a pint of circulating blood one-half degree a minute.

Those who attended other sessions where discussions on electrical computing machines took place know that calculating machines have been getting bigger, better, more complicated and more difficult to operate. They have a long way to go, however, said Dr. McCulloch, before they rival the brain. A big computer with 10,000 vacuum tubes may be a formidable and highly useful machine, but it has no more "intelligence" than a primitive flatworm with about that number of nerve cells.

A New Idea for Cooling Electrical Machines

In the ordinary course of events if someone suggested spraying water into an electric generator, our first thought would be one of consternation. Yet that is what Th. de Koning of Drexel Institute proposed in his paper Vaporization Cooling of Large Electrical Machines. Vaporization cooling according to Mr. de Koning makes a standard universal solution feasible for cooling of large machines of all types. Water is supplied in mist form to the natural surfaces bordering the air gaps. The gap and the space surrounding the end windings are kept under vacuum. Compared with air cooling, the heat transfer coefficient is at least 50 times as great. At full load, 1/80 of the weight and 2/5 to 1/5 of the volume is needed.

Based on the use of the latent heat of liquids, the scheme has many novel implications. Heat losses are removed as evenly as they are generated, air vents, which now make up 4 to 12 per cent of the core length, are no longer needed. The resulting solid stator is explosion proof and corrosion proof; cooling fluids can be applied in accordance with the need; the vapor has small surface friction; both are explosion proof. Fans and filters become superfluous, coolers required for closed circuit cooling become considerably smaller, auxiliary apparatus is hardly needed

Microwave Spectroscopy

One of the outgrowths of the technical developments during the war is the facility in the use of microwaves. One of the most interesting is their use in what has come to be known as microwave spectroscopy. It has been known that certain gases absorb energy at certain ultra-high frequencies. By filling a suitable wave guide with certain gases and applying frequencies over a varying range, definite absorption bands will be noted. It is now known that at these frequencies we actually tune in, so to speak, on the vibrations of the individual atoms.

This technique was described by Dr. D. K. Coles, physicist at the Westinghouse Research Laboratories, in a paper entitled, Microwave Spectroscopy. With this technique, said Dr. Coles, we are able to reveal important new facts on the position of atoms and their chemical and electrical behavior. So precise are these new techniques that it is possible to determine the actual spacing between atoms in a molecule to within a million-millionth of an inch.

Although Dr. Coles did not mention it, this same principle of absorption is used in the new Atomic Clock recently constructed at the National Bureau of Standards. Although now primarily a laboratory

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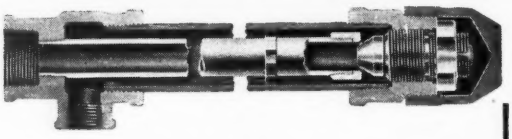

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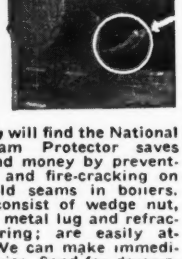

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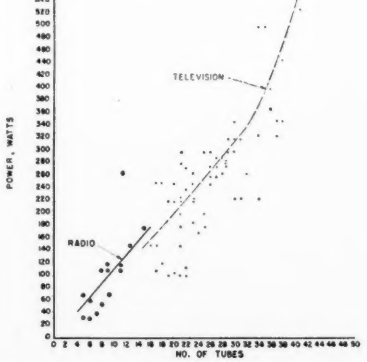
tool for fundamental research, Dr. Coles said the spectroscope may one day develop into an analytical instrument for the scientist working in the field of plastics, chemicals and synthetic materials.

Finding poor connections in transmission lines

During the war, the Germans developed a highly sensitive infra-red detector or bolometer, to accurately track the course of ships through the English Channel by the heat radiated from their smokestacks. These detectors were mounted high on the cliffs near Calais, France. They were so sensitive that they could easily detect the radiation from a person's body a quarter of a mile away.

In a paper by J. R. Leslie and J. R. Wait of the Hydro-Electric Power Commission of Ontario, presented at a session on transmission and distribution, they described how the bolometers have been used for quickly finding overheated (poor)



The average television receiver uses about 250 watts. Ten million of them would give the utilities a good two million kw load

transmission line joints. The idea is very simple. Merely set the bolometer up on a tripod and swing the parabolic mirror which collects the radiation, along the line and when the axis intercepts a hot joint, the instrument instantly responds. In a 2-month period, over 300 transmission line joints were checked by this infra-red detector. Sighting the bolometer on a joint takes less than five minutes.

Synchronized Micro-Time Photographic Techniques

Professor A. M. Zarem of Stanford Research Institute had two papers at the meeting, one in the morning of the first day and the other in the afternoon of the last day. His first discussion on Monday described an electro-optical shutter for photographic purposes, while the second concerned micro-time photographic techniques. Both papers, in a sense, were on the same subject, since they both dealt with the application of the Kerr cell as a camera shutter. By

this device, which was invented over 75 years ago, Dr. Zorem and his associates have been able to take pictures at the rate of 500,000,000 per second. Indeed this technique is so fast and so accurate that it has enabled them to chop off, so to speak, a beam of light 2 ft long. Mr. Zorem described the principle of the shutter by means of a series of simple slides—slides, so simple that, as he explained in apologizing for them, even the admirals could understand them.

The Kerr cell is a simple glass tube containing two parallel-plate electrodes immersed in a solution—nitrobenzine. When electric potential is applied to the plates, the plane of optical polarization is rotated. By placing such a cell between two polaroid screens set at 90 deg, the arrangement normally transmits no light. When a voltage is applied to the plate, however, the plane of polarization of the Kerr cell rotates and a component of the light is transmitted to the camera. Since the action of the cell is practically instantaneous, the shutter can be made to operate in times of a half-billionth of a second.

Edison Medal to Dr. Norris Leeds

The Edison Medal, this year, was awarded to Dr. Norris E. Leeds, Chairman of the Board of Leeds and Northrup Co. of Philadelphia. The award was made at the general session on Wednesday morning by Everett S. Lee, president of the Institute. Dr. Leeds is the 38th recipient of the Edison medal. Charles E. Wilson, President of the General Electric Co., delivered the principal address at this session, his subject being, "The Professional Estate."

ATOMICS

(Continued from page 89)

been known that nuclear radiations have the power to cause "mutations" in the offspring of plants and animals, that is, to interfere with the normal workings of heredity. This fact has tremendous implications, both good and evil, in an atomic age.

On the morning of July 16, 1945, in New Mexico, a herd of cattle was accidentally exposed to the radiation of the first atomic bomb explosion. Today, biologists of the University of Tennessee, in cooperation with the Commission, are studying the breeding records of some of these same cattle and their offsprings. Also, the Tennessee workers are preparing to feed farm animals with radioactive materials and to observe, among other things, how part of the radioactive food, not excreted is distributed among the body tissues and how long it remains. Their main object is to learn whether the milk and meat of such animals is fit for human consumption.

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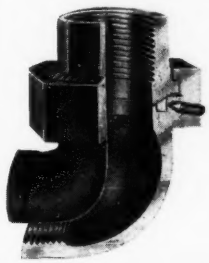

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areas of Bikini and Eniwetok also are under continued study. Aquatic fauna and flora were gathered from the Bikini lagoon and preserved by drying, ashing, quick freezing and by chemical means for laboratory analyses. It is too early to present any conclusive data on the after effects of atomic explosions on plant and animal life but further studies are planned.

Under the medical program, the Commission's most pressing responsibility, is in finding out as much as possible, as rapidly as possible about the injuries that radiation inflicts upon the human body. This work is closely related to the protection of workers in laboratories and plants where they are subject to radiation exposure.

As is well known, studies are under way, in the field of cancer research. Over-exposure to radiation may induce cancer; research workers are now regularly inducing cancer in experimental animals with radioisotopes. Radioisotopes also are being used to trace materials in the body and thus are teaching biologists new facts about the nutrition of cancers. Thirdly, radioisotopes are being used to diagnose the existence of cancer in patients and, to a limited extent, to treat the disease in some of its forms.

It is difficult in a few pages to cover all the multitudinuous aspects of the Commission's report but this abstract emphasizes the most important technical activities. Almost half of the 200-page report is concerned with problems of administration, information service, security, finance and organization. Those interested in those aspects of the work can obtain a copy of the report directly from the U. S. Atomic Energy Commission at Washington.

HOW TO USE HEAT BALANCE IN IMPROVING INDUSTRIAL POWER PLANTS

(Continued from page 108)

remodeling of the existing water softening plant. One of the economical features of this layout is the recovery of blow-down by means of a flash tank, flash condenser, to heat up the water entering the economizer. This recovery alone is estimated to save $6,000 per year.

Figure 6 shows an ultimate layout with a future second boiler installed in place of one battery of the old units, leaving 4 of the present boilers as spares. It also shows the hookup to the two turbines, with the present 750-kw as a spare unit, to be operated through a pressure reducing and desuperheating station or on the spare boilers if necessary.

The bleed pressure of the new unit corresponds to the present plant pressure of 150 psi and will be connected to the 150-lb header of the present distributing system; while the 100 psi supply is through a pressure reducing valve off the 150-psi lb header.

No waste of exhaust steam under normal operating conditions to the atmosphere is contemplated. The 150-lb steam is bled automatically supplying the 150-lb process demands, as well as the 100-lb process demands through a pressure reducing station already on the present 150-lb headers.

Selection of initial pressure and temperature for the turbine design is such that, at the maximum electrical load, there will be no excess of 10-lb exhaust steam over requirements of the 10-lb process steam and, if a slight deficiency occurs, it will be provided through a pressure reducing station from the 150-lb line.

The pressure reducing station from the 400-lb line to the 150-lb line is for operating the present turbine designed for 150-psi when used as a spare. Electrification of several small steam pumps, air compressors and engines is contemplated to improve this balance.

With data thus accumulated, decisions can be reached as to the proper steps to be taken to improve the present heat balance or to provide for contemplated changes. In consideration of new steam and electrical generators, the survey data will dictate the selection of the proper pressures and temperatures, type of generators to be selected, as to bleeder pressures and temperatures, condensing or non-condensing units, and the savings to be effected on the necessary investment.

Make Survey Accurate Enough for Practical Result

It is not expected, in such analysis work, to account for the last Btu generated or distributed; but a practical balance can be made from such an investigation to determine within reasonable limits the division of the various services and their characteristics.

It may be argued that this is a very expensive and lengthy method of analysis. True, if the plant is not large enough and a preliminary inspection reveals that savings may be too small to warrant this method of measurement, other methods can be adopted, such as using the available plant records and costs and estimating the various process demands. However, where there are several processes and the services to them are many, it may be impossible to correlate them without the actual measurements as outlined. It is essential to have such records over 24 hr a day as most process plants operate continuously, to determine relation of steam and electrical demands if an economical solution is to be affected.

Costs of Survey and Results Obtained

Experience has shown that the cost of this type of analysis is very small when compared with annual fuel costs and the benefits to be derived in a properly designed plant, whether it be a new plant, or an old plant undergoing major changes. Investment costs for new equipment will many times be less when accurate data are available as to capacity required. Due consideration is given to future growth and costly mistakes avoided.

As an illustration of the value of such surveys, the atmospheric exhaust head was found emitting steam, but no one had any idea how much steam was being lost. A metering element was designed to meet exhaust steam conditions for a recording flow meter. We found that there were long periods when 15 to 20 per cent of the total steam generated was going to the atmosphere.

It was interesting to notice that this condition continued only a few days after the flow meter was installed. By observing the flow meter, the operators learned how to schedule the process work and reduced this loss about 50 per cent, resulting in considerable fuel saving, which, we estimated, paid for the survey in less than 6 months; yet this was only one of the many benefits and purposes of this survey. This proved so satisfactory that a permanent flow meter was installed to measure this steam being lost to the atmosphere, in order to reduce this loss to a minimum.

In connection with the above study, the contemplated expenditure was $450,000. The saving with the first steam generating unit and the 2500-kw turbine in operation is estimated to be $80,000 per year and with both steam generating units in use, $100,000 per year.

COMING EVENTS

NACE—1949 Conference of the National Association of Corrosion Engineers to be held in Cincinnati April 11-14. Headquarters:—Netherland-Plaza Hotel, Cincinnati.

WMCE—The Sixth Western Metal Congress and Western Metal Exposition will be held at the Shrine Auditorium, Los Angeles, April 11-15.

MPC—The 11th Annual Meeting of the Midwest Power Conference will be held at the Sherman Hotel in Chicago, April 18, 19, and 20, 1949.

AIEE—1949 Meetings of the American Society of Electrical Engineers, South West District Meeting, Dallas, Baker Hotel, April 19-21; Summer General Meeting, Swampscott, Mass. New Ocean House, June 20-24; Pacific General Meeting, San Francisco, Fairmont Hotel, August 23-26; Midwest General Meeting, Cincinnati, Netherland Plaza Hotel, October 17-21.

ASCE—1949 Meetings of the American Society of Civil Engineers, Spring Meeting, Oklahoma City, April 20-23; Summer Convention, Mexico City, July 13-15; Fall Meeting, Washington, D. C., November 2-4.

ISA—The Fourth Annual Spring Meeting of the Instrument Society of America will be held at the Royal York Hotel, Toronto, Canada, May 12 and 13.

ASTM—The 52nd Annual Meeting of the American Society of Testing Materials to be held at the Chalfonte-Haddon Hall, Atlantic City, June 27 to July 1.

ASTM—The First National meeting of the American Society of Testing Materials to be held on the West Coast will be held at the Fairmont Hotel, San Francisco, October 10-14.

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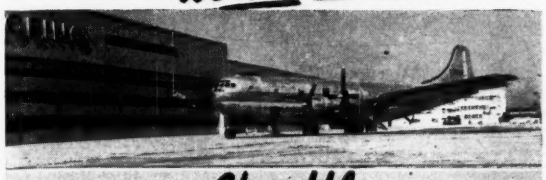

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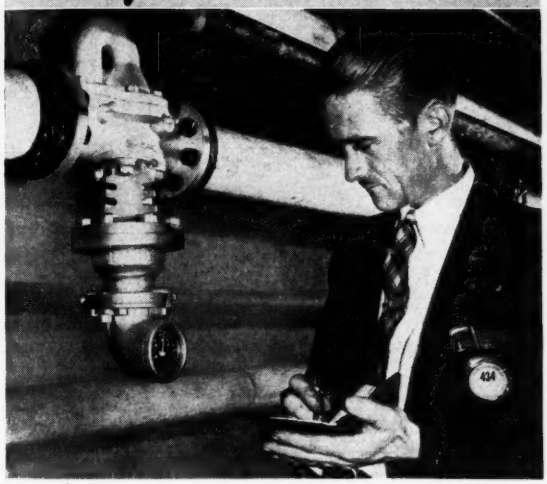

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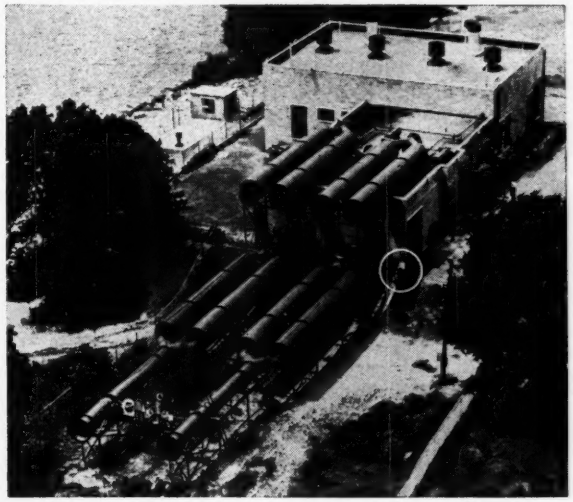

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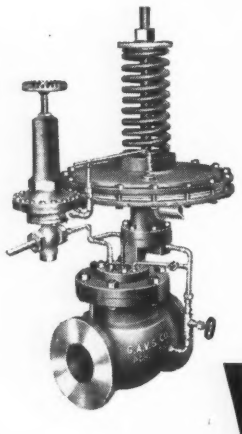

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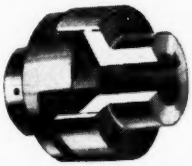

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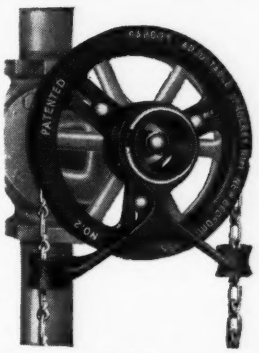

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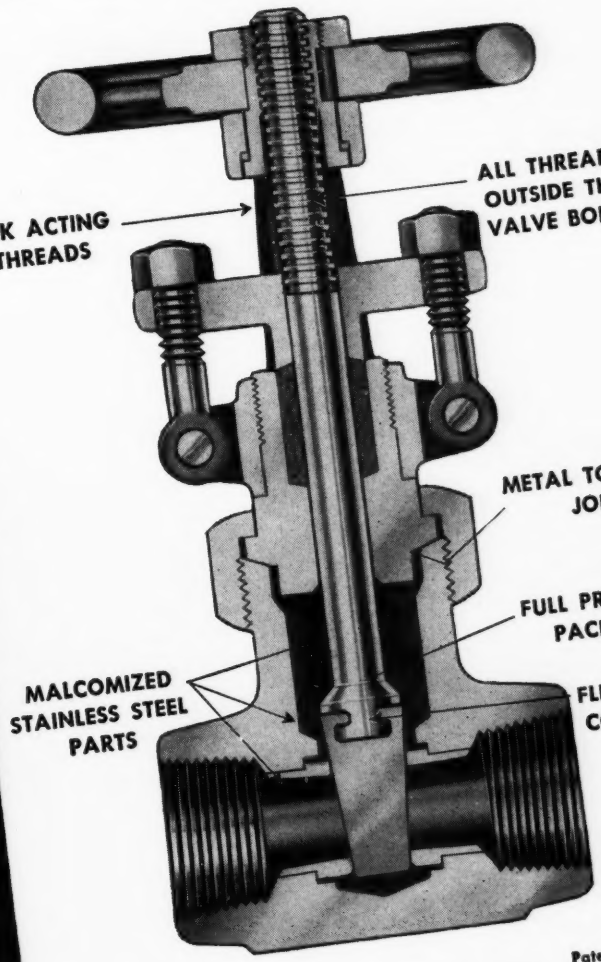

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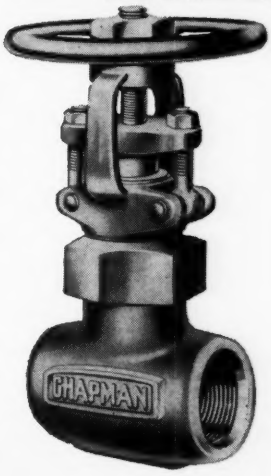

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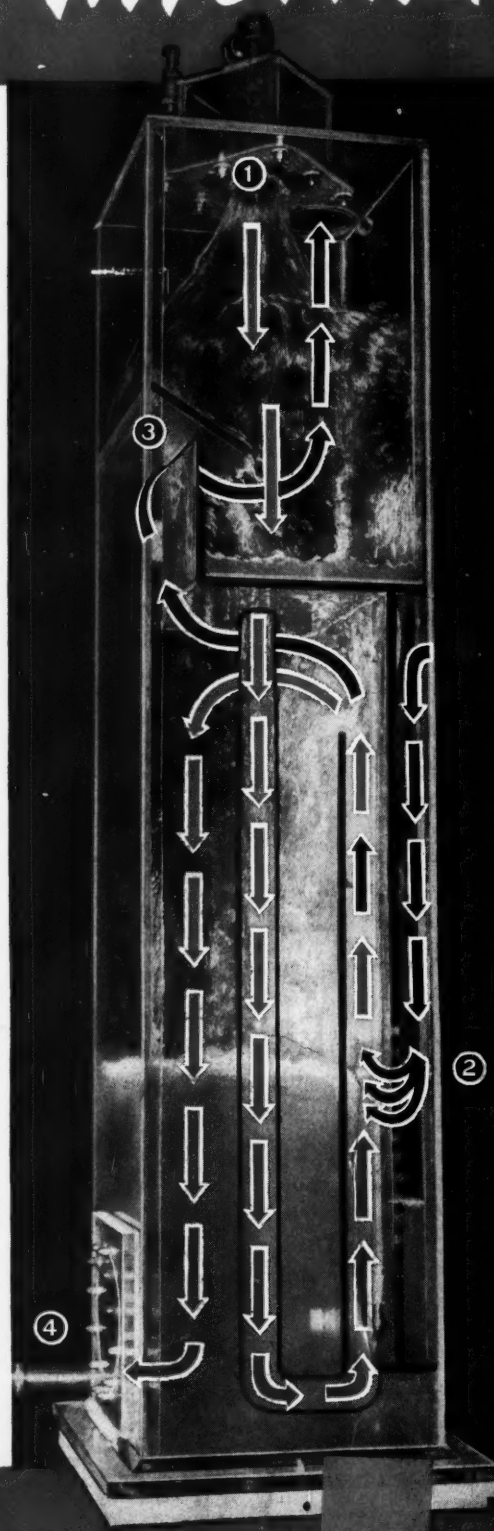

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